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MYCOTAXON

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Volume XXI October-December 1984

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A REVISION OF THE PHACIDIACEAE AND RELATED ANAMORPHS[1]

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> All men by nature desire to know. An indication of this is the delight we take in our senses; for even apart from their usefulness they are loved for themselves; and above all others the sense of sight. For not only with a view to action, but even when we are not going to do anything, we prefer seeing (one might say) to everything else. The reason is that this, most of all the senses, makes us know and brings to light many differences between things.
>
> Aristotle (Metaphysics, Book 1).

INTRODUCTION

The so-called "higher fungi", comprising phylum Dikaryomycota, are divided into Ascomycotina and Basidiomycotina. The Ascomycotina are subdivided on the basis of their asci into the Unitunicatae and Bitunicatae. The Unitunicatae are distributed among 14 orders, of which the Phacidiales is one. The Phacidiales as interpreted by several authors (Arx & Mueller 1954; Darker 1967; Dennis 1968, 1978; Hoehnel 1917a,b,c; Korf 1973; Lanier et al. 1978; Nannfeldt 1932; Rehm 1896; Saccardo 1889; Terrier 1942), is characterized by: 1) a reduced carbonous ascoma, often immersed in the host tissues, 2) a non-amyloid pore or an amyloid dehiscence ring in the ascal apex, and 3) variously shaped, non-septate or phragmoseptate ascospores, which may or may not bear mucilaginous coats or appendages. Three families are recognized by most authors: the Cryptomycetaceae Hoehn., the Phacidiaceae Hoehn., and the Rhytismataceae Chevallier (Arx & Mueller 1954; Darker 1932, 1967; Dennis 1968, 1978; Korf 1973). Hennebert & Bellemere (1979) recognize only two families, Phacidiaceae and Cryptomycetaceae, within the order.

KEY TO THE FAMILIES

1. Ascospores with a mucilaginous coat or appendages..........Rhytismataceae
1. Ascospores without gelatinous coats or appendages.......................2

    2. Stroma of shining brown outer pseudoparenchyma and gelatinous, hyaline inner hyphae which are not vertically oriented.................................Cryptomycetaceae
    2. Stroma of black outer textura globulosa and brown inner hyphae which are vertically oriented.........Phacidiaceae

RHYTISMATACEAE

The Rhytismataceae, containing several important pathogenic species, is the best known and most extensively studied family (Affeltranger 1972; Allit 1979; Darker 1932, 1967; Funk 1967; Graves 1913; Hunt & Ziller 1978; Gremmen 1960b; Korf 1973, 1978; Millar & Minter 1978, 1980; Minter, Millar & Staley 1978; Mitchell & Millar 1978; Ouellette & Magasi 1966; Pirozynski & Weresub 1979; Powell 1973; Sherwood 1980; Skillings & Nichols 1971; Witcher et al. 1975; Ziller 1968; Ziller & Funk 1973). Darker (1932, 1967) summarized much of our knowledge of this economically important family. Hunt & Ziller (1978) provided a key to the Rhytismataceae (= Hypodermataceae) of conifer leaves.

The Rhytismataceae differs from the other two families in several characteristics[3]. The ascomata of fungi in this family possess a covering layer which may open by a longitudinal slit (e.g. *Bifusella crepidiformis* Darker, *Elytroderma deformans* (Weir) Darker, *Hypoderma desmazierii* Duby, *Hypodermella laricis* von Tubeuf, *Lophodermium pinastri* (Schrad.:Hook.) Chev. and *Cyclaneusma niveum* (Pers.:Fr.) DiCosmo, Peredo & Minter. However, in *Coccomyces coronatus* (Schuemacher:Fr.) DeNot. dehiscence is by radially oriented splits in the covering layer. In *Rhytisma acerinum* (Pers.) Fr., the shining black ascomata rupture by irregular cracks in the covering tissue. In *Naemacyclus fimbriatus* (Schw.) DiCosmo, Peredo & Minter the fungal covering layer ruptures in an irregularly stellate manner. These features are also found in the Cryptomycetaceae and Phacidiaceae, and are thus unreliable familial markers.

The microanatomy, ascospore morphology, and anamorphs of the species provide the most useful taxonomic characters. The asci of Rhytismataceae may be saccate, club-shaped to subcylindrical, usually tapering above and below, and the apical region adjacent to the dehiscence pore never gives a positive amyloid reaction[4] in Melzer's reagent when rehydrated in aqueous 2% KOH solution or distilled water alone. However, *Odontotrema rhopalospermum* Kirschst. (Kirschstein 1938), otherwise characteristic of the Rhystimataceae, has asci with a prominent amyloid (I^+) apical dehiscence mechanism. In the Rhytismataceae the ascus apex often has a thin-walled area of dehiscence which tears to release the ascospores, or a delicate pore may be present, viz. *Coccomyces gaultheriae* (Dearness) DiCosmo, Nag Raj & Kendrick, (DiCosmo et al. 1983). The ascospores of the Rhytismataceae are bacilliform, fusiform, bifusiform, club-shaped, or cylindrical to filiform. They may be non-septate to phragmoseptate, and are usually surrounded by a gelatinous coat, or the extremities may bear gelatinous caps or appendages. The ascospores are generally hyaline, except for those of *Nymanomyces* P. Henn., a genus reserved for species with brown ascospores (Darker 1967; Sherwood 1980).

The anamorphs of the Rhytismataceae are usually cited as belonging to *Colpomella* Hoehn., *Crandallia* Ell. & Sacc., *Eriosporopsis* Petr., *Hypodermia* Hoehn., *Leptostroma* Fr., *Leptostromella* Sacc., *Leptothyrium* Kunze: Wallr., and *Melasmia* Lev. (Hennebert & Bellemère 1979; Kendrick & DiCosmo 1979).

CRYPTOMYCETACEAE

The Cryptomycetaceae is a much smaller and apparently less diverse family. Dennis (1968, 1978) recognized only two genera, *Cryptomyces* Greville and *Potebniamyces* Smerlis. Korf (1973) added *Pseudorhytisma* Juel.

The family is characterized by a massive stroma composed of fleshy-gelatinous, hyaline internal hyphae, covered by a shining black roof (Dennis 1968; Korf 1973). Nannfeldt (1932) recognized four distinct tissue types in *Cryptomyces maximus* (the type species of *Cryptomyces*). Such an arrangement is not found in either *Potebniamyces* or *Pseudorhytisma*. Clearly, the Cryptomycetaceae is heterogeneous. The reader is referred to our subsequent discussion of *Potebniamyces*.

PHACIDIACEAE

Generally, the Phacidiaceae is less well known than either the Rhytismataceae or Cryptomyceaceae. Although several interpretations (Hoehnel 1917b; Korf 1973; Nannfeldt 1932; Terrier 1942) have appeared since the family was first erected, no one has previously attempted to characterize the salient, stable morphological features of both anamorphs and teleomorphs. Several researchers (Arx & Mueller 1954; Hoehnel 1917a,b; Lanier et al. 1978; Nannfeldt 1932; Terrier 1942) have focussed on a few species, then proceeded to broad but unjustifiable generalizations. Consequently this family has remained poorly known and vaguely delimited.

The Phacidiaceae as interpreted here contains both pathogenic and saprobic species. The family includes, among others, *Lophophacidium hyperboreum* Lagerberg, the causal agent of 'snow-blight' of Spruce; *Phacidium abietis* (Dearness) Reid & Cain, which causes 'snow-blight' of Balsam Fir; *P. infestans* Karsten and *P. pini-cembrae* (Rehm) Terrier, also well known as 'snow-blight' organisms; *Potebniamyces balsamicola* Smerlis, the cause of 'Phacidiella' bark disease of true firs, and *Potebniamyces coniferarum* (Hahn) Smerlis, associated with bark necrosis of conifers. These fungi are abundant, and are often easily recognized by their characteristic dark fructifications. They attract attention because of the discoloration and subsequent death of the bark, branches and foliage of their hosts. Individual species have been the subject of several critical studies, usually after severe infestations of conifer plantations or nurseries (Faull 1929, 1930). Notable contributions to our knowledge of these fungi have been made by Björkman (1942, 1948), Hoehnel (1909, 1912, 1917a,b,c, 1918), Pehrson (1948), Terrier (1942), Lagerberg (1949), and Reid & Cain (1962a,b). Clearly the family is of some economic importance, but no comprehensive monograph of the group exists. Investigations of the taxonomy and life histories of species of Phacidiaceae, their distribution and their relative pathogenic importance are necessary. This study has focussed on the systematics of the family. Only after the taxonomy of the group has been placed on a firm base can we hope to study distribution patterns and epidemiology.

The life histories involve a fascinating phenomenon known as pleomorphism. In its mycological sense, this term describes a condition in which the genome of a single fungal holomorph will exhibit a sexually reproducing form (the teleomorph), and an asexually reproducing form (the anamorph). When an ascomycete is grown in pure culture, it may form only the teleomorph, only the anamorph, or both phases (the holomorph), or sometimes neither (no sporulation). In the field, the morphs are often temporally and spatially separated. A comparative analysis of ascomycetes without a concurrent study of their anamorphs is now recognized as being inadequate, because the possession of similar anamorphs by rather different teleomorphs may indicate relationship.

After selected species assigned to *Phacidium* had been studied, it became apparent that the genus was in a deplorable taxonomic state. The taxonomic anomalies in current knowledge of both anamorphs and teleomorphs also became obvious.

The generic concept of *Phacidium* as originally proposed (Fries 1815, 1823) is confused and sufficiently diffuse that unrelated species repeatedly found their way into this taxonomic morass. It was clear that anamorph-teleomorph relationships could only be studied in the context of a redefined, more natural, generic concept.

In treating the Phacidiaceae, Dennis (1968) began his key to the group with a symptomatic statement: "Here are assembled the remaining genera not segregated in the preceding two families" (Cryptomycetaceae and Rhytismataceae).[6] Hahn (1957) wrote: "the concepts of the genera in the Phacidiales and their relationships are so conflicting that it is difficult to get a clear cut picture concerning them from the literature....Conflicting opinions also exist concerning the imperfect stages of the Phacidiales..."

Twenty-five years have elapsed since Hahn's pessimistic statement, and no serious attempt has yet been made to revise the Phacidiaceae, despite the fact that many species of this family cause serious conifer diseases.

The anamorphs of the Phacidiaceae provide valuable clues to the classification of the teleomorphs, and to the phylogeny of the group. Most anamorph-teleomorph connections within the Phacidiaceae are based on association of the two phases on the host. This is regrettable, because the intimate association of two forms does not necessarily imply a genetic connection, but often it is the only way of establishing a link between the morphs. If collections of ascomycetes are carefully studied, anamorphs are frequently found intimately associated with the teleomorphs. When the fungi are viable, there is an opportunity to establish a genetic connection between the two phases in pure culture. However, when old, dead collections are studied, only presumptive connections can be postulated, though these can be based on various kinds of evidence. Nag Raj (1979) mentioned four kinds of circumstantial evidence that could be sought and judiciously weighed. (1) Intimate association of anamorph and teleomorph (although the possibility of mycoparasitism must be considered here). (2) Consistent association between the morphs in collections originating from different geographic locales (this really improves the probability of a genetic connection). (3) Occurrence of reproductive structures of both anamorph and teleomorph in the same stroma, or arising from the same mycelium. (4) Similarities of tissue types between anamorph and teleomorph. *Phacidium taxicola* Dearness & House, and its anamorph, *Apostrasseria fusiformis* (Nag Raj 1983) were correlated using a combination of these different types of evidence. The hypothesis was strengthened by evidence from cultural studies of *Phacidium lunatum* DiCosmo, Nag Raj & Kendrick (DiCosmo et al. 1983), a closely related species.

As with the Cryptomycetaceae and Rhytismataceae, the teleomorphs of the Phacidiaceae have received more attention than the anamorphs. Consequently, the teleomorphs have been extensively collected, and usually more adequately identified. As currently delimited, the Phacidiaceae is a heterogeneous assemblage held together by three shared characteristics: (1) the ascomata are black externally, with the hyphae of the covering layer vertically oriented; (2) the ascal apices turn blue in iodine solution; and (3) the ascospores lack gelatinous coats (DiCosmo 1979; Korf 1973; Sherwood 1974). The genera *Ascodichaena* Butin, *Cryptomycina* Hoehn., *Lasiostictis* Sacc., *Lophophacidium* Lagerberg, *Nannfeldtia* Petrak, *Neophacidium* Petr., *Phacidina* Hoehn., *Phacidium*, and *Pseudophacidium* Karsten, have been maintained in the Phacidiaceae by various authors on the basis of these three characters, often with little or no reference to features of the anamorphs.

Tulasne & Tulasne (1861) were among the first to recognize "...those facts...which go to prove that various kinds of fruits and seeds are produced, either simultaneously, or in succession, by the same fungus." Most conidial fungi are considered to be (or to have been) phases of dikaryomycotan fungi. Information derived from conidial anamorphs should therefore be used in any taxonomic consideration of ascomycetes, wherever the inherent connection can be established. A reevaluation of phacidiaceous anamorphs is urgently needed.

The anamorphs of Phacidiaceae are coelomycetes, fungi whose reproductive structures are partly or wholly enclosed in a host or fungal integument during development. The Coelomycetes is still a poorly known group in need of critical reappraisal, despite the recent labours of Nag Raj and of Sutton. Accurate developmental and morphological data are not yet available for the majority of phacidiaceous anamorphs. Hahn (1957) wrote: "Various genera have been reported as being connected with certain ascomycetous genera in the group, i.e., *Ceuthospora* with *Phacidium*, *Myxofusicoccum* with *Myxophacidiella*, *Melasmia* with *Rhytisma*, etc. Most connections have been made merely on association, and how many have been actually proved is doubtful..."

Many of the generic names given to anamorphs of the Phacidiaceae are misapplied, doubtless because the taxonomy of this part of the life cycle has been neglected. Examination of the *Ceuthospora lunata* Shear anamorph of

P. lunatum showed that it belonged in *Apostrasseria* (Nag Raj 1983). The *Phacidiopycnis balsamicola* Funk var. *balsamicola* anamorph of *Potebniamyces balsamicola* Smerlis, and the *Phacidiopycnis pseudotsugae* (Wils.) Hahn anamorph of *Potebniamyces coniferarum* (Hahn) Smerlis, should also be disposed in *Apostrasseria*. The *Myxofusicoccum* anamorph of *Pseudophacidium piceae* Mueller was misidentified, and no anamorph-genus is available for it.

The taxonomy of the conidial fungi should be based on a judicious blend of morphological and developmental features derived from conidiomata, conidiogenous cells, and conidia. Careful weighting of all three important character-complexes is vital in the evaluation of coelomycetous anamorphs. Many anamorph-genera are difficult to segregate on the basis of conidiogenesis alone, but careful scrutiny of conidiomata and conidia may reveal adequate generic differences. Indeed, many coelomycete species have conidia that bear distinctive, even diagnostic, appendages. Pirozynski & Shoemaker (1971) drew attention to some coelomycetes with variously appendaged conidia. These authors contended that "...the conidium appendages, long considered diagnostic, promise to be of even greater taxonomic value when their origin and structure are better understood." We agree entirely.

Genera of coelomycetes associated with the Phacidiaceae contain species with appendaged conidia. These genera need careful reappraisal because of the importance of the group to forest pathologists, who are often working with misleading and misapplied names. The correct application of a generic name to a coelomycete may not seem immediately useful to plant pathologists, but it will undoubtedly help to produce a more 'natural' classification reflecting basic, unifying, taxonomic features. Our knowledge of teleomorph-anamorph connections is still poor. There are few general rules which would help to eludicate the often complex life histories of members of the Ascomycotina. Definite, experimentally obtained proof of genetic connections between anamorphs and teleomorphs is urgently needed. Although mycologists recognize this problem, few attempts have been made to define general rules for linking anamorphs to teleomorphs. The latest attempt was that of Kendrick & DiCosmo (1979). Their main theme centred around the questions: "Will it be possible to match the phylogenetically (*sic*) ordered system of Ascomycetes to the anamorph-classfication of *Fungi Anamorphosium*? Will the teleomorphic classification be supported by the anamorphic classification?" Only when data obtained from all phenotypic expressions of a fungal genome are correlated with precise ecological observations can we hope to approach a rational taxonomic system (Kendrick 1977).

CRITICAL REVIEW OF THE CLASSIFICATION OF THE PHACIDIACEAE

When faced with the problem of classifying a group, the taxonomist will optimally keep two ideas in mind: to establish an accessible system for identification, and to postulate some sort of phylogenetic relationship. Any workable scheme must identify consistent and prominent characters that are readily observable by ordinary means. The second aim can only be satisfied if our chosen, 'significant' characters are homologous rather than analogous.

A chronological review of some classifications proposed for the Phacidiaceae by various authors shows that the limits of the group have been narrowed and its rank lowered.

The 'snow-blight fungi' are perhaps the most conspicuous organisms among the Phacidiaceae. These fungi are frequently abundant, occurring wherever their hosts are found, and often easily recognized by their small, black, and erumpent, to crusty and brittle fructifications found on living or dead leaves and bark. The group has received a good deal of attention from both taxonomists and forest pathologists, yet it remains poorly understood. The last 'modern' taxonomic treatment of the family was that of Terrier (1942).

Persoon (1801), with the description of Xyloma Pers. The name Phacidiaceae is derived from the Greek word for "lentil-shaped", so that originally most genera in the group had lens-shaped fructifications. Not surprisingly, characterization of these fungi was inadequate, since the importance of microscopic details was poorly understood. It is easy to understand why superficially similar but otherwise distinct taxa were grouped in Xyloma in Persoon's order Sclerocarpi, Class Angiocarpi[7]. Also included in the Sclerocarpi was Hysterium.

Official recognition of the Phacidiaceae came with the introduction of Phacidium Fries, which included P. coronatum Fr. and P. integerrimum Fr. (Fries 1815). In that publication Fries alluded to the relationship between Phacidium and Xyloma. Schmidt (1817) characterized Phacidium as having "Perithecia sessilia, varia, primum clausa, dein a centro versus ambitum, in lacinas plures dehiscentia. Asci fixi, erecti thecis ovalibus." Fries (1818) cited eleven species of Phacidium, and described P. lacerum Fr., listed under his group Scleromyci. In 1823, Fries introduced the name "Pyrenomycetes" which included the order Phacidiacei sensu Fries. He realized that the Phacidiacei were aberrant, often cupulate, having "...habitus plane Pyrenomycetum..." Included in the order were Actidium Fr., Excipula Fr., Glonium Muehl., Hysterium, Phacidium, and Rhytisma Fr. At that time Fries recognized twenty species of Phacidium and transferred P. integerrimum to Excipula. Later, Fries (1825) revised his classification of the Pyrenomycetes and included the suborder Phacidiei in his Phacidiacei.

In 1835, Fries transferred the Phacidiacei to his class Discomycetes. He was subsequently followed by Rabenhorst (1840, 1844, 1845). Unrelated taxa were grouped on the basis of "Pileus innato-sessilis subplaniusculus epidermide (nigra) demum rupta involucratus, e thecis oblongis subprominentibus compositus" (Fries 1815).

In 1823, Fries delimited Phacidium with "...Perithecia sessile, subrotundum, simplex, (i.e., simplici substantia formatum), primo clausum, dein dehiscens a centro versus ambitum in lacinas plures, discreta a nucleo disciformi, subpersistente. Asci erecti, fixi, sporidiis uniserialibus referti, immixtis paraphysibus. Hymenium nuclei secedens. Sporidia subovalia."

Schweinitz (1834) followed Fries (1823) in recognizing the Pyrenomycetes as including the Phacidiacei,with "Perithecio ascigero rumpente." The Phacidiacei contained Excipula, Hysterium, Phacidium and Rhytisma.

Phacidium and the Phacidiaceae came to be recognized on the basis of the morphology of the fructification alone. Little or no emphasis was placed on the micro-anatomy of the species. Corda (1842) was among the first to recognize the importance of microscopic details such as spore morphology as useful taxonomic tools. Corda placed Phacidium in the Phacidiei, a subdivision of his Hysteriaceae. The Phacidiei had "Perithecium simplex vel compositum dein stellato-vel irregulariter lobato-apertum. Nucleus discoideus, ascophorus." Here were the genera Heterosphaeria Grev., Phacidium and Rhytisma.

Fries (1849) presented an amplified classification of Discomycetes, and the Phacidiacei were characterized with "...excipulo corneo rimose aut valuatim hiascente."

Tulasne & Tulasne (1861) were among the first to recognize that a single fungal genome was capable of expressing itself as two or more, morphologically distinct, phenotypes, often separated in time and space. In 1865, the Tulasnes treated the Phacidiei sensu Fries. They found that the "...spermatiophorous fungus seems most often to have been overlooked by writers on fungi, or was taken for a Sphaeria or Xyloma; the pycnidial is chiefly reckoned among the Cytisporae and Ceuthosporae..." Tulasne & Tulasne wrote: "...we have no hesitation in considering Phacidium ilicis Lib. to be a fungus that has two forms."

Fuckel (1869/1870) followed the classification of Fries with little alteration. However, the Phacidiacei now contained 17 genera and 71 species, differing in microscopic details, habit and anamorphs.

Karsten (1871) recognized the family Phacidiaceae sensu Karsten but followed Fries' classification with little amplification. He stressed the structure of the fructification and the consistency of the reduced excipulum.

In 1884, Saccardo recognized the family Phacidiaceae with 10 genera grouped on colour and septation of the spores. When Saccardo (1889) again treated the Discomycetes, he attributed the Phacidieae to Fries (1823). Saccardo's concept of the family was little altered from his 1884 version. However, the Phacidieae now contained 16 genera and 264 species. Phacidium alone contained 64 species, and many of the other genera contained species transferred from Phacidium.

Rehm (1896) treated the Phacidiaceae as a division of the Pezizaceae. The Phacidiaceae was divided into the Euphacidiaceae and Pseudophacidiaceae. The Euphacidiaceae contained 5 genera. Rehm was well aware of the presence of anamorphs in this group, writing: "Von einer grossen anzahl sind pycnidien und spermogonien bekannt, bei einigen auch conidienbildungen." He also noted that iodine stained the ascal apices of some species: "...Jod blaeut den schlauchporus", and included this observation in his characterization of Phacidium.

In older classifications of the Phacidiaceae only a few characters were stressed in the delimitation of genera. The gross morphology of the ascoma was perhaps most important, serving to segregate, among others, Coccomyces and Rhytisma, from the bulk of 'phacidiaceous' fungi. Further subdivisions were made on the basis of spore morphology and excipular structure. Many mycologists of that period treated spore shape as the principal determinant. Many taxonomic difficulties arose because workers assigned new species to old, ambiguously delimited genera. Often the importance of excipular details, ascus morphology and dehiscence, and the accompanying anamorphs, was disregarded. Genera became unwieldy, overlaps of spore shape and size occurred, and the relationships between groups of species became lost in a plethora of poorly defined taxa. Between 1847 and 1917 many genera and species were added to the Phacidiacei sensu Fries. Taxa were shuffled around the classification with amazing dexterity. Species and genera were created with a wave of the pen.

The gradual accretion of data pointed to some relationships that could not be ignored. It was the astute studies of Hoehnel (1909, 1912, 1917a,b,c, 1918) that reawakened interest in the Phacidacei of Fries. Hoehnel (1917b) proposed the order Phacidiales. Included in the order was the old Phacidiaceae auct., and some additional genera. Hoehnel then divided the order into six families on the basis of the position of the ascoma with respect to the host. With this, Hoehnel created a constellation of satellite genera reflecting his familial circumscriptions. This meant that related genera like Lophodermium and Hypoderma had to be placed in different families. Hoehnel made no attempt to distribute all the known species into the genera of his new classification. Hoehnel's ideas were not accepted by subsequent researchers, but he did bring some order to the Phacidiaceae and focussed attention on the need to reappraise this heterogeneous group.

Nannfeldt (1932), in his monumental study of inoperculate Discomycetes, treated the Phacidiales sensu Hoehnel, and circumscribed the Phacidiaceae Fr. sensu Nannfeldt, with 14 genera.

Terrier (1942) reexamined the Phacidaceae sensu Nannfeldt, and clearly showed that the family, even as circumscribed by Nannfeldt, still contained discordant elements. Terrier recognized the Phacidiaceae sensu stricto, with only 5 genera: Macroderma Hoehn., Myxophacidiella Hoehn., Myxophacidium Hoehn., Phacidiostroma Hoehn., and Phacidium. Terrier believed that these were all ascolocular and consequently related to the Dothioraceae.

Arx & Mueller (1954) and Mueller & Arx (1962) considered 8 genera to belong in the Phacidiaceae: Cryptomycina Hoehn., Hypodermellina Hoehn., Lophophacidium Lagerb., Neophacidium Petr., Phacidina Hoehn., Phacidium, Pseudophacidium Karst., and Schizothyrioma Hoehn.

Dennis (1968, 1978) in illustrated accounts of British ascomycetes, discussed the Phacidiales, and pointed out that the Phacidiaceae was still heterogeneous and in need of critical study. Dennis (1968) indicated that "two fairly natural families can be segregated...but there remains a large residual group of (12) genera here keyed out together under the Phacidiaceae..."

Kreisel (1969) recognized only four genera in the Phacidiaceae: *Cryptomycina*, *Lophophacidium*, *Phacidiostroma* Hoehn., and *Phacidium*.

Korf (1973) considered the Phacidiaceae to contain 9 genera. He created three tribes: the Coccophacidieae, with one genus (*Therrya* Penzig & Sacc.); the Pseudophacidieae with two (*Nannfeldtia* Petrak and *Pseudophacidium*), and the Phacidieae with six (*Cryptomycina*, *Lophophacidium*, *Micraspis*, *Neophacidium*, *Phacidina* and *Phacidium*).

Barr (1976) presented a key to the families of the Phyllachorales, and included the Phacidiaceae in that order. The Phacidiaceae were recognized as having "ascocarps rounded or elongate, opening irregularly, by long slits or by lacerate flaps, essentially cleistothecioid but appearing apothecioid or hysterioid." Barr noted that the group had little in common with the other two families, Cryptomycetaceae and Rhytismataceae, or the Phacidiales. She realized that the Phacidiaceae included some of the most difficult genera to arrange systematically, but she did not discuss the genera within the Phacidiaceae.

Not too surprisingly, the Phacidiaceae has come to be regarded as a "...poorly defined dumping ground..." (Sherwood 1977).

Lanier et al. (1978) pointed out that the Phacidiales were probably heterogeneous, and accepted only 7 genera in the order: *Cryptomyces* Grev., *Cryptomycina*, *Micraspis*, *Phacidium*, *Potebniamyces*, *Pseudophacidium* and *Therrya*.

Hennebert & Bellemère (1979) and Kendrick & DiCosmo (1979), from surveys of pertinent literature, and largely following the classification advanced by Korf (1973), correlated the teleomorphs and anamorphs of the Phacidiaceae. They noted that the anamorphs of this group were coelomycetes having phialidic or holoblastic conidiogenesis.

Since the establishment of the Phacidiaceae *auct.*, about 30 generic names have been referred to it. Many of these have already been redisposed by various authors. Terrier (1942) recognized only 5 genera in the family. In more recent literature we have found no fewer than 24 genera cited in the Phacidiaceae.

DiCosmo et al. (1983) showed clearly how authors have differed on the disposition of genera in the Phacidiaceae. The only consensus appears to be that the Phacidiaceae is a heterogeneous group, maintained on the basis of three shared characters which may or may not indicate true relationships (monophyly). Many genera have been referred to the Phacidiaceae on the basis of ascoma morphology alone. This has led to utter taxonomic confusion and established the Phacidiceae as a dumping ground for many superficially similar, but distantly related, genera.

During this study we found that no fewer than two hundred species have been described in *Phacidium* alone. Many of these have already been authoritatively redisposed in other genera (DeNotaris 1846; Huetter 1958; Schueepp 1959; Sherwood 1980). However, a large residue of species is left for which no adequate modern treatment exists.

It is the chief purpose of this work to assemble for the first time descriptions and illustrations of both the teleomorphs and anamorphs of all species considered to belong in *Phacidium* and allied genera.

HISTORY OF *PHADICIUM*

The type of a generic name is a type species which is based on type material. It is not unusual for a generic name to be typified by a species that is taxonomically unrelated to, or unrepresentative of, the group of evident when a genus has acquired many species over a long period of time. A survey of the existing literature on *Phadicium* reveals that for many years the genus has not been interpreted in accordance with its type species. Undoubtedly, this misinterpretation has led to numerous nomenclatural and taxonomic problems.

Fries (1815: 167) introduced the genus *Phacidium*, and included two species, *P. coronatum* (Schuemacher) Fr. and *P. integerrimum* Fr.

Schmidt (1817) monographed *Phacidium*, interpreted it in the original sense of Fries, and recognized 11 species.

Fries (1818: 312) described *P. lacerum* Fr.

Fries (1819) provided a description of the genus and listed 13 species in *Phacidium*.

Fries (1823: 571 *ut* 371) included a generic description, 20 species, and cited his earlier publications (Fries 1815, 1818). *Phacidium coronatum* was accepted as a typical member of the genus. However, *P. integerrimum* was transferred to *Excipula* Fr., and *P. lacerum* was considered "...cum Phacid. coronato optima generis species." This, in our opinion, constitutes unequivocal typification of *Phacidium*. It is clear that the name *Phacidium* Fr.:Fr. had its inception with Fries (1815: 167). A type species chosen for this name must not be contrary to what Fries (1815) published, because in 1823 he indicated that his 1815 publication was the source of the name. In 1823 Fries excluded *P. integerrimum* from *Phacidium*, also a clear indication that the generic name rested on *P. coronatum*. When Fries introduced *Phacidium* and subsequently validated the name, he drew upon certain specimens or elements at his disposal for the generic and species descriptions. There can be no doubt as to the material basis of the diagnosis, or what it is, and indeed what genus and species it symbolizes. When Fries (1823) re-validated *Phacidium* he made his 1815 description of the genus and the enumeration of species under that name part of the protologue for it. There is a clear indication in Fries (1823: 571) as to the type species of *Phacidium*. That element must necessarily be *P. coronatum*.

Phacidium coronatum is now known as *Coccomyces coronatus* (Schuem.:Fr.) DeNot. (Sherwood 1980). The combination proposed by DeNotaris is illegitimate and is to be rejected (Art. 63) because *C. coronatus* was based on the type species of *Phacidium*.

At least two important elements appropriate to this discussion have been circumscribed in *Phacidium*: 1) *Phacidium* Fr.:Fr. *sensu stricto*, represented by *P. coronatum*, and 2) *Phacidium* Fr. *sensu* Hoehnel, lectotype species *P. lacerum*. Hoehnel (1917a) considered *P. lacerum* as the type species. But this species was not one of the original taxa included in *Phacidium* by Fries (1815), and cannot be maintained as lectotype unless Hawksworth & Sherwood's 1981 proposal for the conservation of *Phacidium* Fr., with *P. lacerum* as the lectotype species, against *Phacidium* Fr.:Fr., is accepted. Such a proposal appears to constitute flagrant disregard for the principles underlying the Code. Conservation of *Phacidium sensu* Hoehnel would ignore the Code, because we know what *Phacidium* Fr.:Fr. is, and that it was typified by Fries himself. Conservation would violate the type method by actually changing the typification of *Phacidium* Fr.:Fr. This would negate Article 7. Fries (1823) accepted *Phacidium* as he had originally proposed it, and he provided an amended version reflecting his improved understanding of the genus up to 1823. Any proposal to reject *Phacidium* Fr.:Fr. would deny Fries' historical right to be responsible for what he did. Not even the strictest interpretation of the Code does that.

The concept of *Phacidium sensu* Hoehnel arose with Hoehnel's (1917a) revision and misinterpretation of the type species of *Phacidium*. Subsequent authors (Arx & Mueller 1954; Dennis 1968, 1978; Korf 1973; Reid & Cain 1962; Terrier 1942) have all accepted Hoehnel's concept, and generally assumed that the lectotype species of *Phacidium* is *P. lacerum*. But Hoehnel did not really lectotypify *Phacidium*, since his choice of a lectotype species was based on a misinterpretation of the protologue.

Fries (1823) cited several pre-starting point binomials in his synonymy of P. coronatum. Sherwood (1980), in her treatment of Coccomyces coronatus, discussed the fate of the Friesian nomenclator and provided an expanded synonymy. She excluded several of those names from C. coronatus, and considered them to belong to other species. It was pointed out that Xyloma pezizoides Persoon "...opens by a longitudinal slit, a character rarely found in C. coronatus." However, examination of an illustration of X. pezizoides (Persoon 1805), shows that it possesses features characteristic of C. coronatus.

The foregoing discussion has revealed that P. coronatum is the type species of Phacidium. It is well documented (Dennis 1962, 1978; Karsten 1871; Sherwood 1980) that P. coronatum is now known as Coccomyces coronatus. Though it is not the type species of Coccomyces (Darker 1967; Sherwood 1980), it is a typical member of that genus. It becomes evident that Coccomyces is a superfluous name, a taxonomic synonym of Phacidium, which predates it by at least 23 years. Nevertheless, because all authors since Hoehnel have accepted his (incorrect) concept of Phacidium, and because Sherwood (1980) adopted C. coronatus as the lectotype species of Coccomyces, with the (UPS) exsiccatum of Fries' Scleromyceti Sueciae no. 165 as lectotype specimen, and has accepted 51 species in Coccomyces, any effort to reimpose the basic principles of typification and priority (Art. 7, 11) would create massive nomenclatural instability. Thus we shall take up and use the name Phacidium Fr. (Fries 1832) sensu Hoehn. (1917a). For example, adopting Phacidium Fr.:Fr. with P. coronatum as holotype would mean that all species of Coccomyces must be transferred to Phacidium and that those species which we maintain in Phacidium would require a new generic name.

The taxonomic history of the Phacidiaceae has been turbulent indeed. The most recent treatments of the family are those of Dennis (1978), Lanier et al. (1978), and Korf (1973). Each of these authors has interpreted the Phacidiaceae differently. We have found that in all three publications, the family is heterogeneous, containing one or more discordant elements.

A survey of the literature reveals a total of 22 genera ascribed to the Phacidiaceae (Table I). Butin (1977) added Ascodichaena Butin to the family. Whitney, Reid & Pirozynski (1975) believed that Darkera Whitney, Reid & Pirozynski was 'phacidiaceous'. Thus, 24 genera have been referred to the Phacidiaceae by recent authors. Some of these genera have already been authoritatively redisposed in other families (Table II).

Our review of some of the previous classifications advanced for the Phacidiaceae by various workers shows that any 'clarification' that has emerged has resulted from a narrowing of the limits of the complex, usually after some taxonomic devaluation of the characteristics used. Any workable classification must be based on consistently observable and prominent characters, easily demonstrable by 'ordinary' means. These characters should also be significant phylogenetically. This, of course, is a matter of interpretation, and experts often disagree (Dennis 1978; Korf 1973; Lanier et al. 1978).

Those faced with the problem of classifying a group must aim to produce a workable scheme that represents the natural relationships of the group. The checkered history of the Phacidiaceae exemplifies the difficulties arising from this two-fold objective. We have adopted the traditional stance of narrowing the scope of the family, not by devaluing the characteristics used, but by the introduction of a previously untapped data base, the anamorph.

Table I. Genera placed in the Phacidiaceae by recent authors.

1. *Ascodichaena* Butin
2. *Cryptomycina* Hoehnel
3. *Darkera* Whitney, Reid & Pirozynski
4. *Didymascella* Maire & Saccardo in Maire
5. *Laqueria* Fries
6. *Lasiostictis* (Saccardo & Berlese) Saccardo
7. *Lophophacidium* Lagerberg
8. *Macroderma* Hoehnel
9. *Melittosporium* Corda
10. *Micraspis* Darker
11. *Myxophacidiella* Hoehnel
12. *Myxophacidium* Hoehnel
13. *Naemacyclus* Fuckel
14. *Nannfeldtia* Petrak
15. *Neophacidium* Petrak
16. *Phacidina* Hoehnel
17. *Phacidiostroma* Hoehnel
18. *Phacidium* Hoehnel
19. *Potebniamyces* Smerlis
20. *Pseudophacidium* Karsten
21. *Rhabdocline* Sydow in Sydow & Petrak
22. *Schizothyrioma* Hoehnel
23. *Sphaeropezia* Saccardo
24. *Therrya* Penzig & Saccardo

Table II. Disposition of Genera of the Phacidiaceae *auct.*

Ascodichaena Butin	Dermateaceae
Cryptomycina Hoehnel	Cryptomycinaceae
Darkera Whitney, Reid & Pirozynski	Hemiphacidiaceae
Didymascella Maire & Saccardo	Hemiphacidiaceae
Laqueria Fries	(?)
Lasiostictis (Saccardo & Berlese) Sacc.	Rhytismataceae
Lophophacidium Lagerberg	Phacidiaceae
Macroderma Hoehnel	Rhytismataceae
Melittosporium Corda	Hysteriales (?)
Micraspis Darker	Leotiaceae (?)
Myxophacidiella Hoehnel	Dermateaceae
Myxophacidium Hoehnel	Dermateaceae
Naemycyclus Fuckel	Rhytismataceae
Nannfeldtia Petrak	Leptopeltidaceae
Neophacidium Petrak	Rhytismataceae
Phacidina Hoehnel	Leptopeltidaceae
Phacidiostroma Hoehnel	Phacidiaceae
Phacidium Fries	Phacidiaceae
Potebniamyces Smerlis	Dermateaceae (?)
Pseudophacidium Karsten	Hemiphacidiaceae
Rhabdocline Sydow	Leptopeltidaceae
Schizothyrioma Hoehnel	Leptopeltidaceae
Therrya Penzig & Saccardo	Rhytismataceae

PHYLOGENY

We interpret the Phacidiaceae in a restricted sense, as incorporating only two genera, Lophophacidium and Phacidium (= Phacidiostroma). The remaining twenty-one genera previously ascribed to the family are excluded from the Phacidiaceae sensu DiCosmo, Nag Raj & Kendrick. DiCosmo, Nag Raj & Kendrick (1982) used P. taxicola to illustrate the salient morphologcal features of Phacidium and the Phacidiaceae.

The Phacidiaceae have traditionally been considered along with the Rhytismataceae as members of the Phacidiales, and this order is thought to be related to, but taxonomically independent of, the Helotiales. The reduced ascomata of the Phacidiaceae sensu lato have provided the basis for classifying these organisms, and have undoubtedly misled many students of this group. We have found that in the past the family circumscription has included at least 80 genera of immersed, but unrelated ascomycetes. However, as we now know, any classification of the teleomorphs must be based on all features, rather than a selected few. Difficulties in classifying the group have arisen because of the difficulties encountered in obtaining the necessary information from the reduced ascomata. However, we have found that the Phacidiaceae sensu DiCosmo, Nag Raj & Kendrick have several good taxonomic features which are indicative of relationships within the Helotiales.

In the Helotiales, ascomata of the teleomorphs vary greatly in size and morphology, are discoid, cupulate to stipitate and are innate-erumpent or superficial on host tissues. The 2- to 8-spored asci are club-shaped, with a simple, non-amyloid apical pore, or an amyloid dehiscence mechanism. Sometimes the ascus apex tears irregularly to release the ascospores. The non-septate to phragmoseptate ascospores are usually smooth, hyaline or pigmented, and variously shaped. They are either radially symmetrical, or may show bipolar asymmetry. Paraphyses may be present or absent. Species in the Helotiales are usually parasites or saprobes on plant hosts.

A survey of the families in the Helotiales shows that the Dermateaceae are characterized by erumpent to stipitate, darkly pigmented ascomata of textura globulosa to textura angularis or textura epidermoidea. The anamorphs of the Dermateaceae show blastic-phialidic conidiogenesis (Corniculariella Karsten, Foveostroma DiCosmo, Gelatinosporium Peck, and Topospora Fries; DiCosmo 1978; Nag Raj & DiCosmo 1981). The Dermateoideae (of the Dermateaceae) are recognized by the amyloid ascus dehiscence mechanism which recalls that of the Phacidiaceae sensu DiCosmo, Nag Raj & Kendrick. These groups also occupy similar niches.

The genus Phacidium incorporates inoperculate ascomycetes characterized by the externally black stroma with vertically arranged pseudoparenchymatous cells forming the covering layer or roof; club-shaped, 4- to 8-spored asci with amyloid dehiscence rings, and usually non-septate, ellipsoid, hyaline ascospores with no gelatinous coats or appendages. The paraphyses are invested in mucilage, and may be longer than the asci, but are usually more or less the same length, frequently anastomose, and arise from the subhymenium. The anamorphs show blastic-phialidic to blastic-annellidic conidiogenesis. The conidia are either subcylindrical with a funnel-shaped, mucilaginous apical appendage (Ceuthospora), or ellipsoid with an irregular, mucilaginous apical appendage (Apostrasseria). Both the ascomata and conidiomata of Phacidium vary considerably in structure in the different species. This range of variation in form suggests a kinship with the Helotiales.

Considered in toto the comparative anatomical data suggest that the Phacidiaceae are related to the Dermateoideae of the Dermateaceae. This postulate leads us to propose the removal of the Phacidiaceae sensu DiCosmo, Nag Raj & Kendrick from the Phacidiales and its transfer to the Helotiales. Consequently, the Cryptomycetaceae and Rhytismataceae (of the Phacidiales auct.) will now constitute the Rhytismatales, a reduced, but more logical derivative of the Phacidiales.

MATERIAL AND METHODS

Our data are derived from observations of dried herbarium material, freshly collected specimens, and some pure cultures. Slide preparations made from properly rehydrated herbarium specimens were often indistinguishable from those made with fresh material. In all cases we tried to study type material. When the depauperate condition of the specimen precluded this, authentic material identified by the original author was used. In addition to type or authentic material, other representative collections of each species were examined, except for those species which are represented only by the type collection. Pure cultures (on Difco Potato Dextrose Agar)[8] derived from mass ascospore or conidium inoculations were incubated at 20°C and periodically checked for sporulation. No ascomata were seen, and conidiomata were few and undiagnostic of the species as they occur on natural substrates. This was not unexpected, since the fungus normally fruits in the context of a host tissue.

Portions of material (3 mm X 2 mm) bearing sporomata were excised from the specimen to be studied, and rehydrated overnight in distilled water, or in water plus 1-2 drops of lactic acid. If the material was woody, rehydration was followed by soaking for 10-15 minutes in aqueous 2% KOH solution (w/v). After soaking, the material was rinsed several times in distilled water, oriented in a drop or two of a water-soluble resin[9] on the stage of a freezing microtome, frozen, and sectioned at 10-15 µm. The sections accumulated on the blade and were transferred, several at a time, with a fine pin to a small dish of distilled water. Sagittal sections were selected under a dissecting microscope and transferred individually with a fine pin to a drop of lactic acid (85-90%) on a microscope slide. The slide was inverted and lowered onto an 18 mm square, Number 1 coverslip. Excess mountant was carefully blotted from the slide around the coverslip with a tissue, and the mount sealed with "Glyceel"[10]. The resulting semi-permanent preparation will keep for up to 5 years. The procedure was repeated for other sections mounted in glycerol-chloral hydrate medium[11].

Other sections were transferred to a drop of distilled water on a microscope slide and teased apart with fine pins under a dissecting microscope. The preparation was inverted onto a coverslip, a drop of lactic acid was placed at one edge of the coverslip, and the water was drawn off from the opposite edge with absorbent paper. Sections of ascomata were transferred to 2% KOH solution for 30-60 seconds and checked for any potassium hydroxide positive (KOH^+) reaction. Other sections were then rinsed several times in distilled water, transferred to a drop of Melzer's reagent[12], and observed for iodine positive (I^+) reaction in the ascal apices.

Unstained preparations were studied under Neofluar phase-contrast optics (Carl Zeiss), stained sections were studied under bright field illumination. Good sections, mounted whole, usually yielded much of the information needed for identification. However, conidiogenous cells of the coelomycetous anamorphs were too densely packed for details of conidium development to be resolved. This information was obtained by making several tease and squash mounts from sections left over from the previous steps.

The conidia of the coelomycetes studied have characteristic mucilaginous appendages or sheaths which are often invisible in lactic acid. These were detected in water mounts or in a dilute, aqueous solution of methylene blue.

Most of the specimens studied were kindly loaned by the curators of the herbaria listed in the "specimens examined". The abbreviations used are those found in Hawksworth (1974), and Holmgren & Keuken (1974, 1976, 1977, 1978).

MORPHOLOGY AND DEVELOPMENT OF THE TELEOMORPH

The development of ascomata is a process that is usually easily followed. Ascomata can be isolated, fixed and sectioned or studied alive in all stages of development. Despite this, ascoma development in the Phacidiaceae has been the subject of controversy. Terrier (1942) provided descriptions of the ascomata of Phacidium abietinum Kze. & Schm., P. infestans Karst., P. lacerum Fries, and P. pini-cembrae (Rehm) Terrier. He found that the stromata of these species were composed of a homogeneous tissue of vertically oriented hyphae between which the asci arise. Furthermore, the vertical hyphae were connected with the cells of the covering layer. After this connection is broken, the hyphal elements from the covering layer remain suspended, directed toward the hymenium. Terrier also found that the paraphyses grow densely from the outset.

Lagerberg (1949) confirmed Terrier's observations, and found that the covering is much thicker in the central region, that the tips of the paraphyses are in contact with the lower, hyaline layer of covering hyphae, and that the hyaline hyphae of the covering are invested in a gelatinous substance. He confirmed Hoehnel's (1917a) observation that the peculiar construction of the interior of the fungal covering served as a dehiscence mechanism, an idea that Nannfeldt (1932) had dismissed. These conflicting interpretations of the development and function of various parts of the ascoma in the Phacidiaceae suggested that this area needed reappraisal, and further observations.

The developmental sequences in the unitunicate Ascomycetes are usually characterized by reference to the development of the hymenium. The mode of hymenial maturation and its exposure to the atmosphere provides the basis for two diverging types of development termed "gymnocarpic" and "angiocarpic". As these terms have often been interpreted, if the hymenial initial is exposed from the beginning, or if it becomes exposed during ascospore maturation, the development is gymnocarpic. If the hymenium develops inside a closed locule the development is angiocarpic. Brummelen (1967) showed that these terms have been used in different senses by different authors. He correctly pointed out that the terms related only to the hymenium during certain phases of ascoma development, and not to the fructification as a whole.

Brummelen (1967) introduced and defined several terms, of which we have adopted the following:

1. Archihymenial phase: before the hymenial initials are formed (usually that phase before paraphyses are initiated).

2. Prohymenial phase: when paraphyses are discernible, but no croziers are yet present.

3. Mesohymenial phase: paraphyses and immature asci are present.

a) An early mesohymenial phase is often characterized by the initiation of croziers.

b) The mid-mesohymenial phase is recognized when croziers proliferate and cytoplasm begins to condense around haploid nuclei within the asci.

c) The late-mesohymenial phase is characterized by the presence of some mature asci.

4. Telohymenial phase: the majority of asci are mature and ascus dehiscence proceeds.

5. Posthymenial phase: the hymenium is effete and in a state of degeneration.

Our observations of many thin sections of preserved herbarium material at various stages of development, led us to conclude that ascoma development is similar to that found in some members of the Rhytismataceae (Campbell & Syrop 1975; Duravetz & Morgan-Jones 1971; Jones 1935; Morgan-Jones & Hulton 1979; Uecker & Staley 1973). However, we need much more information from the study of pure cultures and from developmental studies of fresh collections, before the sequence can be fully established.

DEVELOPMENT OF THE ASCOMA

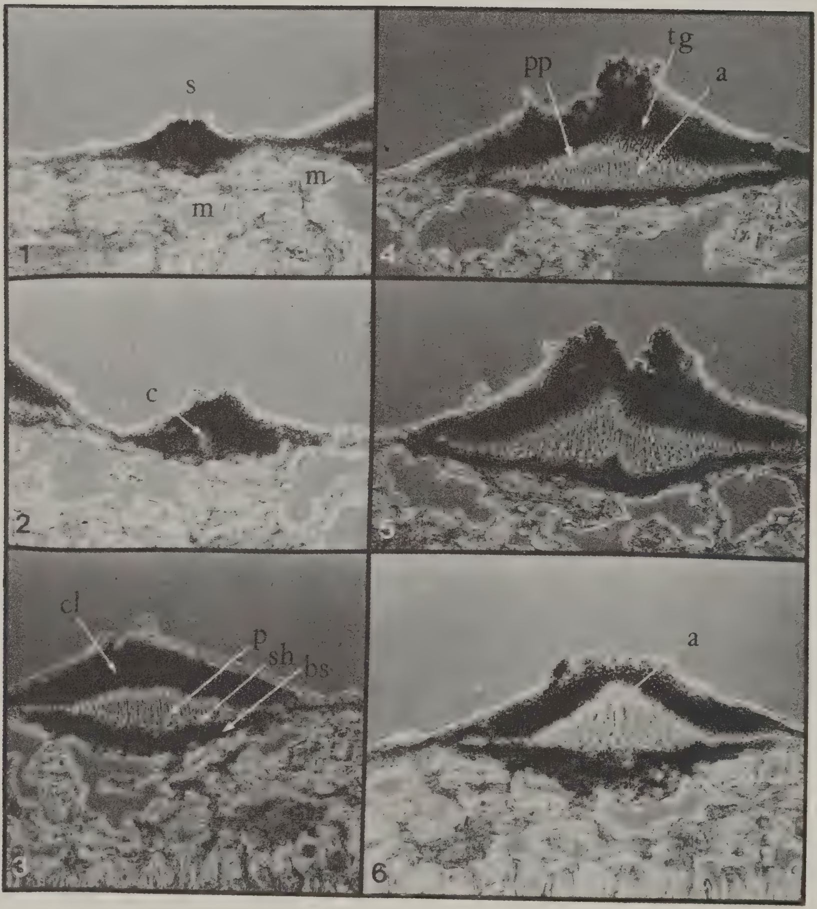
In Figs. 1-6, gross developmental sequences for ascomata of P. lunatum are presented. The intracellular mycelium (m) (Fig. 1) gives rise to a subcuticular, compact stroma (S), which is the ascoma initial (archihymenial phase). The incipient ascoma is composed of dark brown, carbonaceous, pseudoparenchymatous cells forming a textura globulosa. The archihymenial phase persists through Fig. 2: note that in the lower central portion of the young, undifferentiated ascoma, centrum development (c) is evident. Further development (Fig. 3) illustrates the prohymenial phase. Paraphyses (p) have arisen from the subhymenium (sh), which rests on a well developed basal stroma (bs). Most of the stroma is elevated to form a fungal roof or covering layer (cl) over the developing hymenium. The prohymenial phase is illustrated in Fig. 4. Paraphyses and immature asci (a) are now present in a well developed, single, closed locule. The textura globulosa (tg) of the roof is readily identifiable. This tissue terminates in smooth-walled periphysoids (pp) invested in mucilage. The roof is well developed (Fig. 5), and a central area shows evidence of rupture. This is the early mesohymenial phase. Young asci are clearly visible. The mid-mesohymenial phase is illustrated in Fig. 6. Cytoplasm has condensed around the nuclei of some asci (a). The central apical area of the covering layer is relatively thin, further growth will ultimately rupture the cover to expose the hymenium, which will have some mature ascospores.

As seen in median vertical sections, the phacidiaceous ascoma is a loculate stroma. In Phacidium spp. this stroma encloses a single cavity in which the paraphyses and asci develop from the pseudoparenchymatous subhymenium.

Our observations of P. lunatum raise several questions, which are basic, not simply to the Phacidiaceae, but to the overall classification of the Ascomycetes. Do all species now retained in the Phacidiaceae sensu DiCosmo, Nag Raj & Kendrick, show similar development? What is the nature of the hyphae that occupy the ascoma cavity? Are they pseudoparaphyses as suggested by Nannfeldt (1932) and Hennebert & Bellemère (1979), or are they true paraphyses? Are there separate systems of ascogenous hyphae and sterile hyphae that give rise to asci and paraphyses, respectively? How are the ascogenous elements initiated? The answers to these questions will undoubtedly help to produce a better classification of the Phacidiaceae and Ascomycotina. However, ontogenetic differences may be of little taxonomic use, since different patterns may sometimes be present in ascomycetes that are regarded as being closely related. Nevertheless, variations in centrum development should be documented, because we cannot afford to ignore any potentially significant criteria in such taxonomically difficult groups as the Phacidiaceae.

Having examined serial sections of 26 species of Phacidium and 1 species of Lophophacidium, we believe that the developmental sequence for all species now retained in the Phacidiaceae is essentially the same.

We have found that both ascogenous elements and paraphyses arise from the subhymenium. In addition, an ascogenous cell may proliferate to produce several croziers; several such systems, along with paraphyses, comprise the hymenium. Such systems have been demonstrated in P. lunatum, P. betulinum (Fig. 211), P. coniferarum (DiCosmo 1981), several other Phacidium spp., and other taxa treated here, such as Potebniamyces pyri (Fig. 101); Schizothyrioma ptarmicae (Fig. 130); and Pseudophacidium kumaonense (Fig. 447). In many species of Phacidium there is a basal connection between an ascus and an adjacent paraphysis. We could not determine whether the ascogenous elements were derived from the basal cells of the paraphyses, or from separate ascogenous cells of the subhymenium. In any event, proliferation of ascogenous elements involved crozier formation, implying the existence of a dikaryophase. As Morgan-Jones & Hulton (1979), indicated, the dikaryotic condition may be initiated by the kind of anastomoses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Phacidium lunatum. 1, 2. Archihymenial phase. x 125. 3. Prohymenial phase. x 125. 4. Further development of the prohymenial phase. x 190. 5. Mesohymenial phase. x 125. 6. Mid-mesohymenial phase. x 125. (See text for explanation.)

frequently observed during the present study (Figs. 98, 212).

Karyological observations of *P. lunatum* paraphyses showed that each of their cell is uninucleate. Therefore, anastomosis of adjacent paraphyses could initiate the dikaryophase, especially if they were heterokaryotic. Our findings thus support those of Gordon (1966), Morgan-Jones & Hulton (1976, 1979) and Stephan (1971), in suggesting that ascus formation probably follows anastomosis between adjacent paraphyses.

We have shown that such anastomosis occurs in several species from different families. This suggests that the pattern of centrum development found in the Phacidiaceae, and in other groups treated herein, may be widespread. Corlett (1967, 1968, 1971) reported this phenomenon among the bitunicate ascomycetes.

In an attempt to resolve the controversy centred around the nature of the hyphae that occupy the ascoma cavity, we made a detailed study of many thin sections of young ascomata of *P. infestans* (DAOM 105364). We can report that the immersed mycelium (m) of *P. infestans* (Figs. 7-10) is composed of branched, septate, pale yellow to pale brown, smooth-walled hyphae, 2.5-4 µm wide, with a mucilaginous sheath.

Incipient ascomata are subepidermal, initially composed of a mass of undifferentiated, hyaline, branched, septate, frequently anastomosing hyphae 2-3 µm wide, forming a *textura intricata* (ti, Fig. 7) immersed in a mucilaginous matrix. It is from this meristematic tissue that the basal stroma and fungal covering layer eventually arise. The hyphae in the peripheral region become slightly wider (3-4 µm) and form a *textura porrecta* as the stroma matures. In the basal region, the hyphae are densely compacted. Toward the apex, the hyphae become agglutinated, pale brown, darker above, and form a *textura epidermoidea* (te, Fig. 9). This is thickest toward the centre, and will ultimately form the covering layer (cl) which matures centrifugally.

Careful examination of sections of young ascomata reveals a hyphal connection between the roof and the basal stroma. Despite what Terrier (1942) said, the connecting hyphae do not represent the 'paraphyses'. In the roof of the maturing ascomata, the elements of the covering layer become vertically oriented and thicker, forming a *textura globulosa*. The undifferentiated, internal hyphae of the stroma proper ultimately begin to deliquesce, adding mucilaginous material to the developing locule and swelling the ascoma.

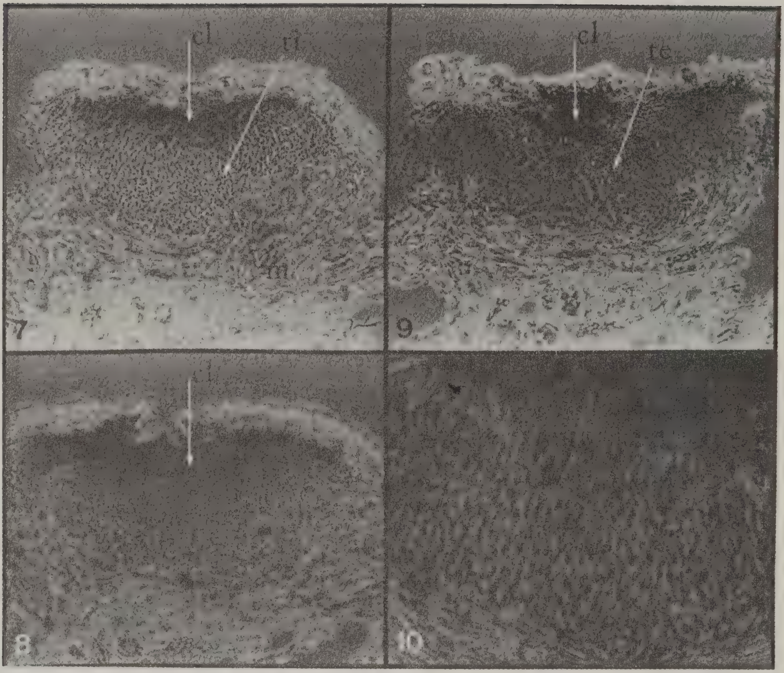
We were unable to find separate trichogynes and ascogonia. The penultimate cell of the crozier is ascogenous, the ultimate cell proliferates to form subsequent croziers. The paraphyses are initiated from cells adjacent to the ascogenous cells. We could not demonstrate conclusively whether croziers or paraphyses were initiated first.

The mature ascoma is uniloculate, with a hymenium of asci and paraphyses. The fungal covering tissue becomes raised into irregular swellings which ultimately rupture stellately from the centre. The lobes of the covering become variably reflexed, exposing the hymenium.

From these observations it appears that the young ascomata are loculate stromata in which paraphyses are delimited as supposed by Lagerberg (1949). Contrary to these observations, Bellemère (1967) found in one species of *Phacidium* (*sub Phacidiostroma multivalve*) that: "les filaments interascaux...ne sont donc pas des paraphyses ascendantes mais des filaments paraphysoides rompus à leur partie supérieure."

The patterns of development demonstrated for *P. lunatum*, and *P. infestans* also occur in *P. lacerum*. By examining serial sections of ascomata at various stages of maturation, we elucidated its mechanism of ascoma dehiscence; the sequences observed in that species apply to all species of *Phacidium*.

As already pointed out, the mature ascoma is a loculate stroma. The vertical section of *P. lacerum* Fr.:Fr. illustrated in Fig. 11 represents the periphery of an ascoma. There is a continuity between the basal stroma (bs) and the covering layer (cl), these two tissues geing connected by parallel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ti
m
7
cl
te
9
cl
8
10

Phacidium infestans ex DAOM 105364. 7-9. Stages of development during the prohymenial phase. x 770. 10. Detail of *textura intricata* occupying developing locule. x 1280.

columns of wide hyphal elements (he) composed of subcylindrical cells. Vertical sections taken toward the interior of the ascoma revealed that the hymenium is well developed before any rupture of the fungal covering layer is apparent (Fig. 12). The asci and paraphyses are embedded in a mucilaginous matrix (presumably secreted by the paraphyses), and are touching the periphysoids (pp), which are also immersed in a copious (and even denser) mucilaginous material. Examination of a vertical section of an ascoma during the late mesohymenial phase (Fig. 13), shows that the periphysoids (pp) and the paraphyses are separate systems. The opposing pressures exerted by the growth of these elements and the concomitant increase in volume of the hydrophilic mucilage (presumably by imbibition of water, and continuing secretion of mucus by periphysoids and paraphyses) ultimately split the covering layer (Fig. 14). The covering layer remains attached to the basal stroma by wide hyphae (arrows, Fig. 14). During dry periods, the mucilage around the periphysoids and paraphyses loses water and shrinks. The hyphae at the periphery of the ascoma also lose water, and retract. These processes pull the reflexed lobes or teeth of the covering layer back over the hymenium to form a protective integument. During humid periods, imbibition of water causes the 'teeth' to bend back and uncover the hymenium. This remarkable mechanism was first noted by Hoehnel (1917a), refuted by Nannfeldt (1932), but finally confirmed by Lagerberg (1949).

MORPHOLOGY AND DEVELOPMENT OF THE ANAMORPHS

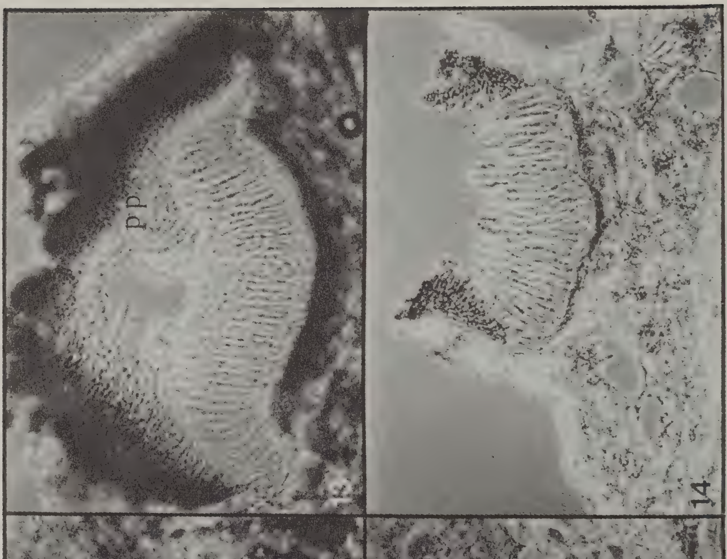
The anamorphs of Phacidium have been classified in the anamorph-class Coelomycetes: anamorph-order Sphaeropsidales auct. While some of these anamorphs develop alongside their teleomorph, others occur at a different time and place from the teleomorph. This spatial and temporal separation has resulted in utter taxonomic confusion among anamorph-species and genera. The Apostrasseria anamorph of P. coniferarum has been described as three different species, in no fewer than four genera. It is clear that taxonomists and plant pathologists have not fully appreciated the nature of coelomycetous anamorphs. Archer (1926) demonstrated this in studies of some Sphaeropsidales in culture. Several authors have stressed the need for pure culture studies of coelomycete development if we are ever fully to understand the phenotypic variation presented by these fungi (Archer 1926; Coons 1916; Creager 1933; Leonian 1924). We have observed that coelomycetes produce atypical conidiomata when cultured in the laboratory on synthetic media, and we stress the need for more penetrating studies of anamorphs from natural substrates. We documented previously unsuspected morphological variation by examining herbarium material, fresh material and some pure cultures. But we did not follow the route taken by many mycologists, and concentrate on pure culture studies, because these would not have given us the unequivocal results we obtained from material on natural substrates.

The morphologies of anamorphs of Phacidium are described and documented throughout this study. Descriptions of individual anamorph-species are given immediately after those of their associated teleomorphs.

DEVELOPMENT OF THE ANAMORPH

The anamorphs of Phacidium are coelomycetes that produce conidia in characteristic closed receptacles called pycnidial conidiomata. The integument of these conidiomata is composed of pseudoparenchymatous cells forming a compact textura globulosa to textura epidermoidea. These tissues become less stromatic toward the hymenium, grading into textura prismatica or textura angularis. Ultimately, the hymenium arises from the innermost cells of the integument.

In an effort to understand more about the developmental sequences leading to the formation of conidiomata, we studied the development of an unidentified isolate of a Ceuthospora generously supplied by Dr. A. Arambarri of LPS.



Phacidium lacerum ex Thuemen 717 in NY. 11-13. Serial vertical sections of a developing ascoma illustrating the organization of the centrum and various tissues. x 125. 14. V.S. of a mature ascoma. x 125. (See text for details.)

The first indication of conidioma formation is the appearance of tight, subspherical, pale yellow hyphal aggregations (50-100 µm diam.), 3-4 days after inoculation. During this initial phase, the hyphae forming incipient conidiomata are branched and septate. After 5 days the primordium has become more or less flask-shaped (200-300 µm diam.) and pigmented. The outer hyphae are agglutinated, heavily melanized, and form a young textura globulosa to textura epidermoidea. No mature conidiogenous cells are present. After 7-8 days, the entire conidioma (350-400 µm diam.) is heavily melanized. The apical area around the developing ostiole appears to be most heavily stromatic, and three distinct tissues are recognizable. The outermost tissue is composed of subglobose, darkly pigmented cells forming a textura globulosa. The inner wall tissue is essentially a pale brown textura epidermoidea which becomes subhyaline to hyaline toward the hymenium. Young conidiophores arise from the innermost cells of the developing locule.

The conidiomata usually produce viable conidia after 10 days. The mature conidioma is a flask-shaped structure with a well-developed wall, and an ostiole derived from lysis of internal tissue. The conidia are subcylindrical, rounded at the base, and tapered toward the apex, which bears a mucilaginous, funnel-shaped appendage.

During this study it became evident that the individual hyphal elements of conidiomatal primordia were invested in a mucilage that bound adjacent hyphae together. The conidiogenous cells and conidia were also produced in a mucilaginous matrix in the locule of the conidioma. The conidia ultimately developed a mucilaginous apical appendage, as Figs. 177, 188 clearly show.

Pirozynski & Shoemaker (1971) suggested that useful taxonomic information could be derived from studies of the structure and development of conidium appendages. Figs. 183-188 illustrate the developmental sequence found in the presumed Ceuthospora anamorph of P. aquifolii (this pattern applies to all species of Ceuthospora we have studied, and probably to all species of the genus).

Development of the first-formed conidium was not observed. Although this probably differs in certain respects from that of subsequent conidia, this is inherent in the 'start-up' phase of a conidiogenous cell like a phialide, and will not conceptually change the general condition which we describe.

A conidium initial is formed at the tip of a phialide (Fig. 179). In water mounts, the conidiogenous cell and conidium initial are seen under phase contrast to be invested in a mucilaginous matrix, which is not discernible in lactic acid. Further growth produces a subcylindrical conidium (Figs. 180-182). At this point there is no evidence of an appendage. Fig. 183 illustrates the first recognizable sign of appendage development. The subapical area of the growing conidium is now slightly narrower, and a mucilaginous cap is present. We cannot explain how this narrowing occurs. Finally, the mucilaginous cap everts to form a funnel-shaped appendage, and the conidium is eventually set free from the conidiogenous cell. Stages in the eversion of the appendage were observed in dilute aqueous methylene blue (Figs. 185-187). It seems that the amount of mucilaginous material increases during the formation of the appendage (compare the apical cap in Fig. 185 with that in Fig. 186).

Prior to this study, appendage development in Ceuthospora had not been investigated. It was assumed that the conidiogenous cells and conidia of Ceuthospora spp. were invested in an over-all mucilaginous matrix. At maturity, a circumscissile split occurred in the mucilaginous sheath around the conidium, the apical portion then everted and formed the characteristic appendage. This view is no longer tenable and it apears that appendage development (in Ceuthospora spp. at least) is more complex than was suspected.

We found that the mucilaginous matrix around the conidiogenous cells and young conidia is readily soluble in water, invisible in lactic acid, and stains rarely, very poorly, or not at all, in aqueous methylene blue. The appendage, however, stains well in aqueous methylene blue, and is clearly visible in lactic acid or water alone. This suggests that the two mucilaginous materials may differ in chemical composition.

TELEOMORPH-ANAMORPH RELATIONS

In the past, *Phacidium* has been distinguished from other genera largely on the basis of ascoma morphology. An externally black, carbonaceous stroma with vertically arranged pseudoparenchymatous cells in the covering layer, asci with amyloid dehiscence mechanism, and non-septate ascospores with no gelatinous coats or appendages, were considered typical for the genus. *Phacidiostroma* was segregated because it produced a stroma that occupied the entire host-leaf thickness, or occurred under the epidermis of stems and extended deeply into the host tissue. *Potebniamyces* was distinguished because its ascomata were not united with host tisssues. These criteria are now perceived to be inadequate.

The recognition by certain authors that the anamorphs of some species of *Phacidium* were species of *Ceuthospora*, subtly changed the concept of these genera. Potebnia's (1912) recognition of a *Phacidiopycnis* anamorph for *Phacidiella* provided an auxiliary character that was subsequently used to segregate *Phacidiella* from *Phacidium*. Undoubtedly the vague similarity of conidia of *Phacidiopycnis*, *Apostrasseria* and conidia of *Phomopsis* led to taxonomic confusion and misinterpretation of generic limits. We have found it necessary to redefine the limits of both teleomorphic and anamorphic genera.

It has been shown that no species of *Phacidium* has a *Phacidiopycnis* anamorph. Anamorphs of *Phacidium* originally considered to belong in *Phacidiopycnis* have been transferred to *Apostrasseria*. Hoehnel (1925) listed *Ceuthospora* anamorphs for species of *Phacidium*. We have confirmed some of Hoehnel's observations.

Six species of *Phacidium* (*P. abietinum*, *P. lunatum*, *P. balsamicola*, *P. coniferarum*, *P. dearnessii*, and *P. taxicola*) produce *Apostrasseria* anamorphs and are well-known pathogens. The nature of *P. pusillum* is not yet known, but it is included here because of its *Apostrasseria* anamorph. No anamorphs have yet been discovered for *P. abietis*, *P. infestans*, and *P. pini-cembrae*, but these species have been included in the above grouping because of their pathogenicity.

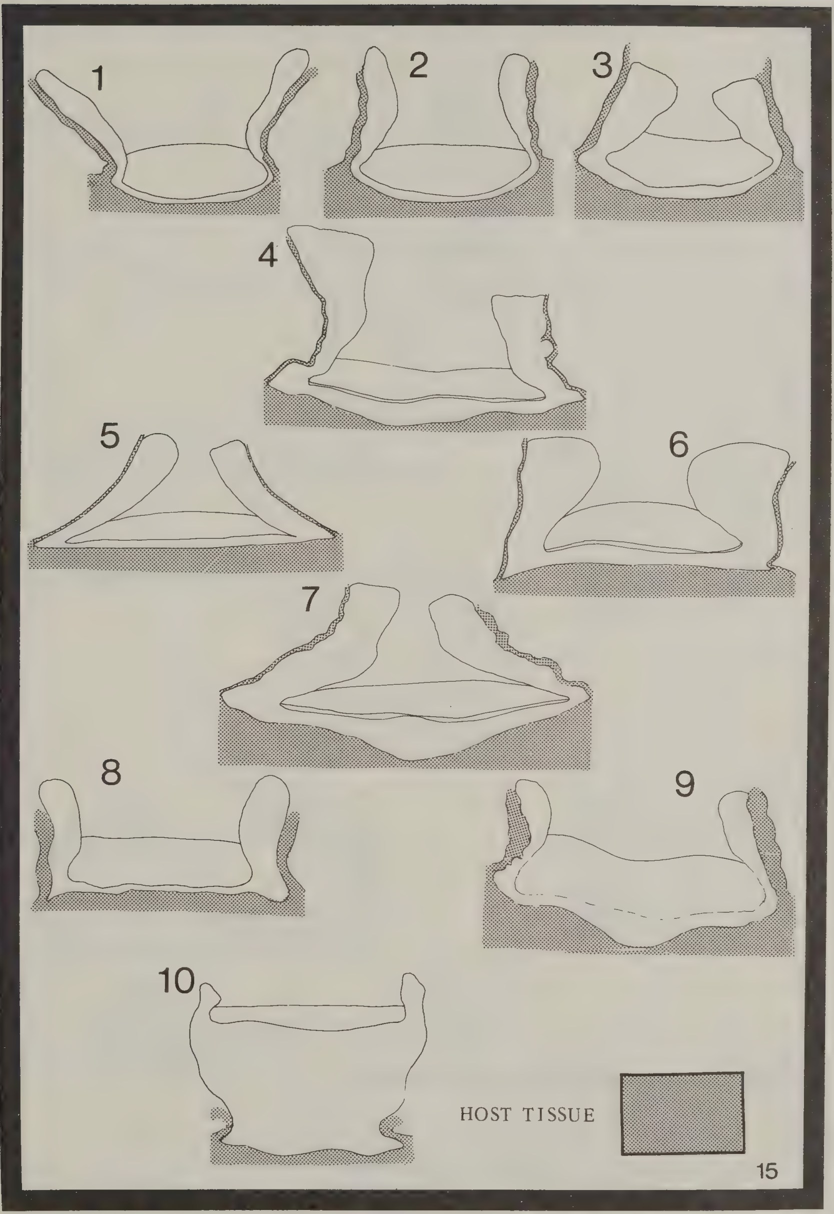
The other group of *Phacidium* spp. (*P. aquifolii*, *P. arbuti*, *P. betulinum*, *P. cicatricola*, *P. eucalypti*, *P. gaeumannii*, *P. heteromelis*, *P. lacerum*, *P. multivalve*, *P. salicinum*, *P. sherwoodiae*, *P. vaccinii* and *P. vincae*) produce *Ceuthospora* anamorphs and are considered to be saprobic species. The anamorphs of *P. grande*, *P. sphaeroideum*, and *P. vestergrenii* have yet to be found. These three species are tentatively placed in the saprobic group.

MORPHOLOGICAL VARIATIONS AND ADAPTATIONS

In Fig. 15, species of *Phacidium* which have *Apostrasseria* anamorphs are represented diagrammatically. Fig. 16 illustrates the anamorphs. The first three species in Fig. 15 (1: *P. infestans*, 2: *P. pini-cembrae*, 3: *P. abietis*) have been included because of their pathogenicity. If anamorphs are ever discovered for these species, we believe that they will be referable to *Apostrasseria*.

The saprobic species of *Phacidium* are illustrated in Fig. 17, and their anamorphs appear in Fig. 18. *P. sphaeroideum* has been excluded from Fig. 17 because of its close morphological similarity to *P. heteromelis*.

One is immediately impressed by the range of morphological variation presented by both series of *Phacidium* spp. and their respective anamorphs. Consider *P. coniferarum* (Fig. 15). The ascoma is erumpent, even appearing superficial on the host, and the hymenium rests on a well-developed basal stroma. The *Apostrasseria* anamorph of *P. coniferarum* (Fig. 16) presents an erumpent conidioma (often in close association with the ascomata) that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HOST TISSUE
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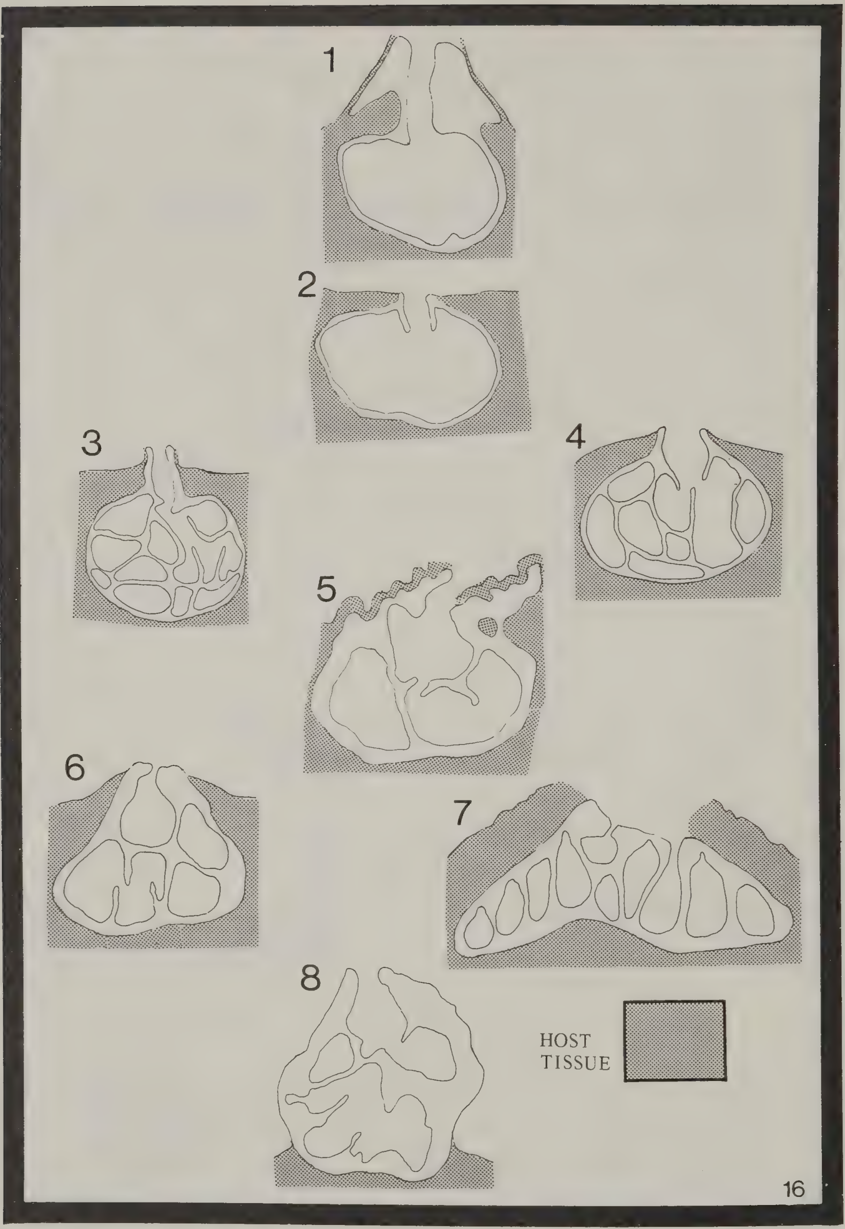
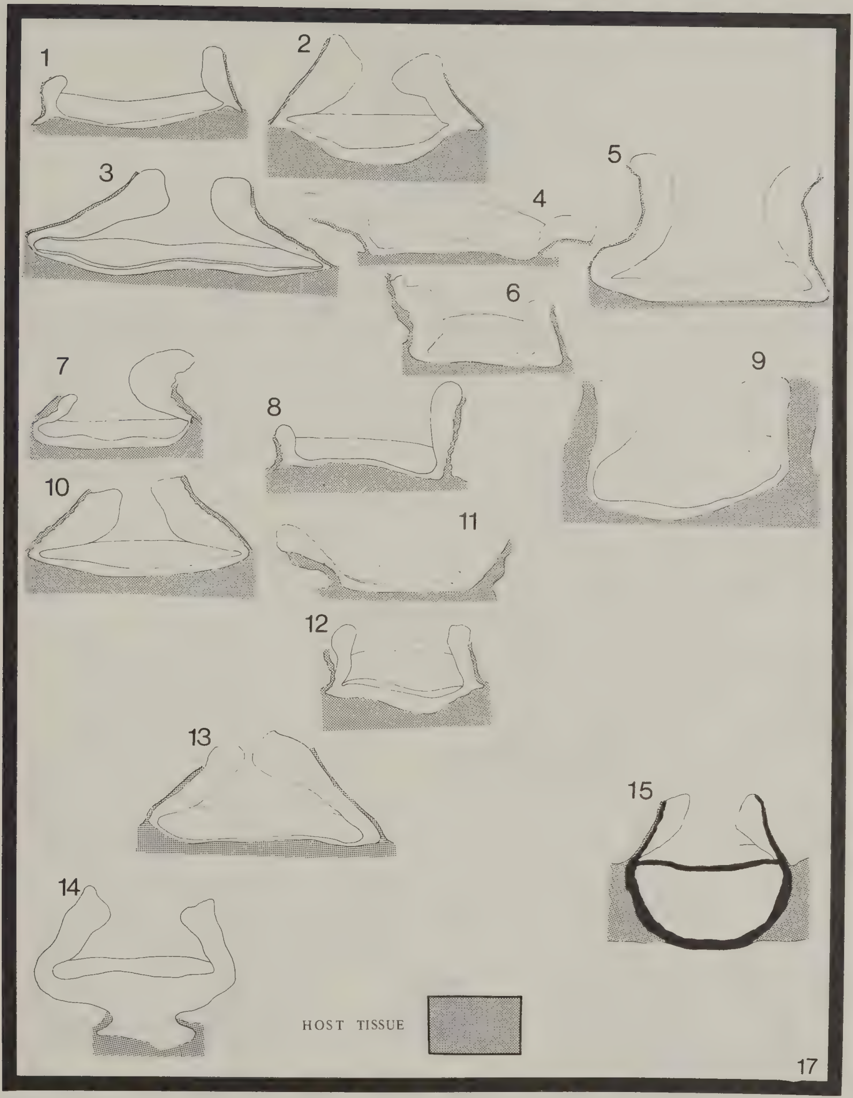
15. Diagrammatic sections of the ascomata of pathogenic Phacidium spp. 1. P. infestans. 2. P. pini-cembrae. 3. P. abietis. 4. P. taxicola. 5. P. lunatum. 6. P. pusillum. 7. P. dearnessii. 8. P. balsamicola. 9. P. abietinum. 10. P. coniferarum.



16. Diagrammatic sections of conidiomata of *Apostrasseria* anamorphs of pathogenic *Phacidium* spp. 1. *Apostrasseria* anam. unknown *Phacidium*. 2. *Apostrasseria fusiformis* anam. of *P. taxicola*. 3. *Apostrasseria lunata* anam. of *P. lunatum*. 4. *Apostrasseria* anam. of *P. pusillum*. 5. *Apostrasseria robusta* anam. of *P. dearnessii*. 6. *Apostrasseria balsamicola* anam. of *P. balsamicola*. 7. *Apostrasseria* anam. of *P. abietinum*. 8. *Apostrasseria* anam. of *P. coniferarum*.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HOST TISSUE
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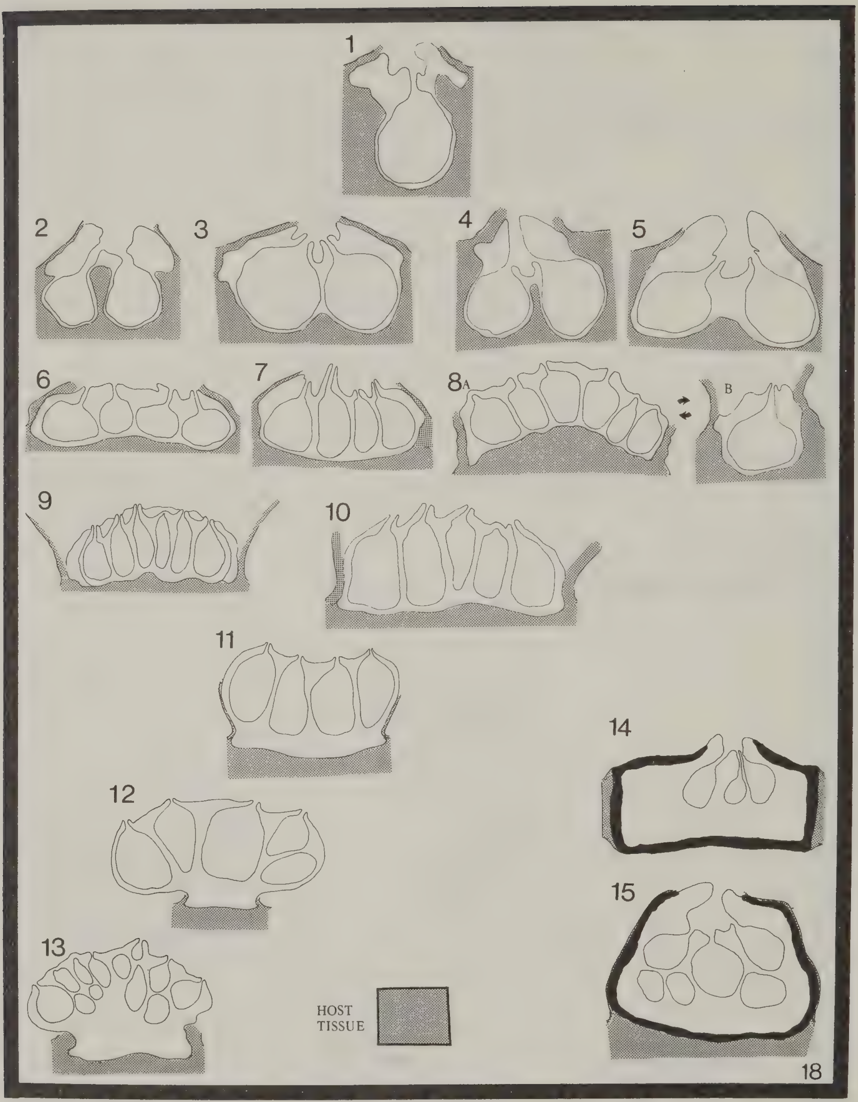
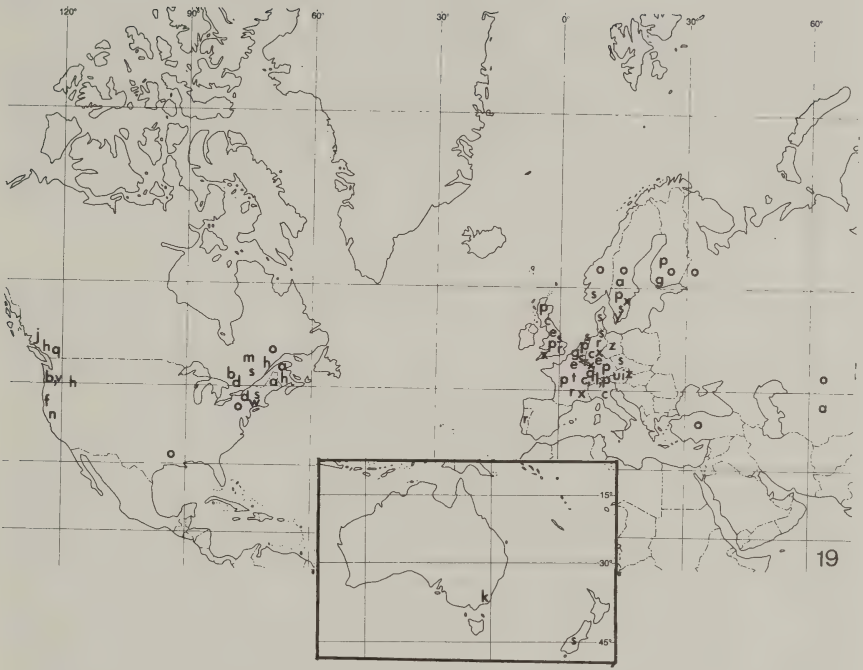
17. Diagrammatic sections of the ascomata of saprobic *Phacidium* spp. 1. *P. vestergrenii*. 2. *P. grande*. 3. *P. aquifolii*. 4. *P. arbuti*. 5. *P. vincae*. 6. *P. heteromelis*. 7. *P. salicinum*. 8. *P. eucalypti*. 9. *P. lacerum*. 10. *P. vaccinii*. 11. *P. cicatricola*. 12. *P. betulinum*. 13. *P. sherwoodiae*. 14. *P. gaeumannii*. 15. *P. multivalve*.



18. Diagrammatic sections of conidiomata of *Ceuthospora* anamorphs of saprobic *Phacidium* spp. 1. *Ceuthospora photinicola* anam. (?) of unknown *Phacidium*. 2. *Ceuthospora* anam. of (?) *P. aquifolii*. 3. *Ceuthospora* anam. of *P. arbuti*. 4. *Ceuthospora* anam. of *P. heteromelis*. 5. *C. foliicola* anam. of *P. vincae*. 6. *Ceuthospora salicina* anam. of *P. salicinum*. 7. *C. pyrolae* anam. of unknown *Phacidium*. 8. *C. pinastri* anam. of *P. lacerum*. 9. *C. latitans* anam. of *P. vaccinii*. 10. *C. cicatricola* anam. of *P. cicatricola*. 11. *C. subcorticalis* anam. of *P. betulinum*. 12. *Ceuthospora* anam. of *P. sherwoodiae*. 13. *Ceuthospora* anam. of *P. gaeumannii*. 14. *C. phacidioides* anam. of *P. multivalve*. 15. *Ceuthospora* anam. of unknown *Phacidium*.



19. World Distribution of Phacidiaceae *sensu stricto*.

a. *Lophophacidium hyperboreum*
b. *Phacidium abietis*
c. *P. abietinum*
d. *P. lunatum*
e. *P. aquifolii*
f. *P. arbuti*
g. *P. betulinum*
h. *P. balsamicola*
i. *P. cicatricola*
j. *P. dearnessii*
k. *P. eucalypti*
l. *P. gaeumannii*
m. *P. grande*
n. *P. heteromelis*
o. *P. infestans*
p. *P. lacerum*
q. *P. pini-cembrae*
r. *P. multivalve*
s. *P. coniferarum*
t. *P. pusillum*
u. *P. salicinum*
v. *P. sherwoodiae*
w. *P. sphaeroideum*
x. *P. vaccinii*
y. *P. vestergrenii*
z. *P. vincae*

often appears superficial, and is heavily stromatic. The two phases show similar morphological variations and adaptations to the host. The immersed, somewhat stromatic ascoma of P. dearnessii (Fig. 15) is correlated with an immersed, relatively stromatic anamorph (Fig. 16), oriented similarly to the host tissues.

Such correlations between teleomorph-anamorph pairs, and their relation to the various host tissues, are clearly evident in the accompanying illustrations (Figs. 15, 16, 17 and 18). Two natural groupings based on anatomy, anamorphs, and modes of nutrition (parasitic vs. saprobic), have emerged. Furthermore, these groupings appear to represent parallel evolutionary sequences showing the fungal fructifications evolving either from an exposed situation to become more deeply immersed in the host tissues, or vice versa -- we cannot tell which direction evolution has taken. The figures present a sequence, starting with the least complex species (i.e., 1 in each Fig.), and proceeding to the most complex. Distribution of the species we accept in Phacidium is shown in Fig. 19.

SPORE RELEASE AND DISPERSAL MECHANISMS

Teleomorphs of Phacidiaceae show a marked seasonality. From examination of the collection data for parasitic species of Phacidium, it appears that in the boreal zone, ascomata are initiated in autumn, mature during the winter, and release mature ascospores in the spring and early summer, presumably to infect young, more easily penetrated, host tissues. Such systems are widespread in the Ascomycetes. We differentiate between the processes of spore release and dispersal. Meredith (1973) suggested that spore release was the process by which propagules were set free from sporomata. We prefer to define spore release as the process that liberates a propagule from its parent cell (conidiogenous cell, ascus, basidium or sporangium). Dispersal is the process by which the spores are carried from their point of release to the infection site. Meredith (1973) provides an admirable review of the significance of spore release and dispersal in plant disease epidemiology. We shall consider only the Phacidiaceae and their anamorphs.

There are two basic types of spore release mechanism, active and passive. Both are demonstrated by species of the Phacidiaceae. The teleomorphs of the Phacidiaceae produce ascospores in meiosporangia called asci, that violently expel the ascospores. We have already demonstrated that the asci of the Phacidiaceae sensu DiCosmo, Nag Raj & Kendrick possess a prominent apical dehiscence ring. The mechanism of ascospore discharge is the controlled bursting of the turgid ascus. The mature spores are liberated through the elastic, apical dehiscence aperture. Ingold (1966) found that the range of asci varied considerably, depending on the size of the propagule.

It is instructive to note the sequence of events leading to spore release and dispersal in species of Phacidium. When a mature ascoma imbibes water, the covering layer (roof) reflexes and exposes the hymenium. This mechanism ensures that the hymenium is exposed only during periods of high humidity conducive to spore release. Once the hymenium is exposed to the environment, mature asci become turgid and subsequently expel their ascospores explosively through the elastic apical ring. The actively liberated ascospore is then passively dispersed by air currents. This seemingly simple observation could have significant effects upon programs attempting to control snow-blight diseases. The hymenium of these fungi is exposed, and ascospores released, only during periods of high relative humidity.

Passive spore release and passive dispersal are observed in the anamorphs of Phacidium spp. The conidia of Apostrasseria spp. and Ceuthospora spp. are produced at the apices of conidiogenous cells in flask-shaped conidiomata. The mature conidia secede by the separation of the layers of a double septum that develops in the narrow isthmus between the conidia and the parent cell (see Fig. 192). These spores have a mucilaginous apical appendage and are exuded en masse in a slimy droplet through an opening at the apex of the conidioma.

The slime found in conidiomata of species of Apostrasseria and Ceuthospora was highly surface-active. When slime droplets were placed in a drop or two of distilled water, the droplet dissolved completely in 1-5 seconds, and conidia were found largely at the air-water interface. We noted that many conidia, especially of Ceuthospora spp., subsequently became attached by their apical appendages to the surface of the microscope slide. Apostrasseria conidia generally remained at the air-water interface, and their appendages were most soluble in water.

Rain is a well recognized agent, both for release and dispersal of spores. Fungi dispersed by rain are assumed to have a restricted distribution from a source. Water-dispersed conidia are often slimy, but we should not assume that all slimes function in the same way. Ceuthospora spp. have two types of slime. One binds the conidia in droplets, is surface active in water, and effectively aids spore dispersal. The other forms the spore appendages, and is probably adhesive, ensuring that the spores become attached to a substrate. Undoubtedly, much remains to be learned about spore release and dispersal in the snow-blight fungi.

THE GENERA

1. Ascodichaena Butin

Type species: A. rugosa Butin
Anamorphs: Dichaenopsis notarisii Paoli
Psilospora faginea (Pers.) Rabenh.

Butin (1977) established the genus Ascodichaena for the single species, A. rugosa. It has been widely accepted that the anamorph of this species is Polymorphum rugosum (Fr.) Hawks. & Punith. (Hawksworth & Punithalingam 1973). Butin (loc. cit.) provided evidence for this connection by repeated field observations of A. rugosa throughout its growing season. He found that it had both a macroconidial anamorph and a microconidial (spermatial?) anamorph. Both anamorphs begin growth in the spring, the microconidia maturing in April or May. The macroconidial anamorph matures in June and July, when the teleomorph can also be found (fide Butin 1977).

Recently, Butin & Parameswaran (1980) studied the ultrastructure of A. rugosa anam. P. rugosum, and discussed the host-fungus interaction. They found that A. rugosa is parasitic on the immature cork of the phellem layer of Fagus sylvatica. They classified the fungus in the Phacidiales (Butin 1977).

The proper systematic position of A. rugosa is enigmatic. It was called Dichaena faginea (Chev.) Sacc., in earlier literature, and has been the source of controversy and speculation for over two centuries (Butin 1977; Speer 1980b). The name Dichaena Fr. (1825) has been used for both a coelomycete and an ascomycete.

Rehm (1896) discussed the relationship of Dichaena with the Phacidiaceae and concluded that it was better retained in the monotypic Dichaenaceae. He illustrated D. quercina (= D. faginea) with a habit drawing, an ascus, and two ascospores. Lindau (1897), Paoli in Sacccardo & Saccardo (1905) and Arnaud (1914) all concluded that the name Dichaena should be applied to an ascomycete. Arnaud (1914) noted the close similarity between Henriquesia Passerini & deThuemen and Dichaena. Bisby (1941), however, concluded that reports of asci and ascospores for D. quercina were erroneous. After examining British material, Bisby found, "...that the pycnidial state of Dichaena quercina is nearly as uncertain as the ascigerous." Undoubtedly, Bisby examined immature, infertile material.

Butin (1977) conclusively demonstrated the presence of asci and ascospores. He found that the early reports of asci and ascospores for D. faginea were fallacious, and introduced the new genus Ascodichaena. He placed A. rugosa in the Phacidiaceae because he considered it to be related to *Pseudophacidium*, and because of its "...mostly rounded fruitbodies, as well as the unicellular hyaline spores and unitunicate asci." He found that the asci have a thin-walled apex, no dehiscence pore and are non-amyloid (I^-).

Ascus and ascospore morphology of *A. rugosa* recall those of *Darkera parca* Whitney, Reid & Pirozynski (Hypodermataceae, Hunt & Ziller 1978). However, the ascomata of these two fungi are quite different. The ascoma of *D. parca* is characteristic of some members of the Rhytismataceae. *A. rugosa* produces a black, stromatic ascoma with internal *textura angularis* and external *textura globulosa* (see Butin 1977) reminiscent of the Dermateaceae of the Helotiales. The holoblastic anamorph, *P. rugosum* (Hawksworth & Punithalingam 1973; Morgan-Jones 1974) seems quite out of place in the Dermateaceae, which generally possess blastic-phialidic anamorphs. The recent discovery of a second anamorph in the life cycle of *A. rugosa* seems to resolve this apparent paradox.

The fungus produces conidiomata that resemble those of *P. rugosum* (Fig. 20B) except that conidiogenesis is phialidic rather than holoblastic (Fig. 20A). This suggests that *Ascodichaena* (see Speer 1980b for a complete synonymy) could be placed in the Dermateaceae.

Recently, Speer (1980a,b) discussed the names *Ascodichaena*, *Dichaena*, *Dichaenopsis* Paoli (Paoli 1905), *Polymorphum* and *Psilospora* Rabenhorst (Rabenhorst 1856). He found that *Dichaena* is the earliest legitimate name for *Ascodichaena*. He also found that *Psilospora faginea* (Pers.) Rabenh. is the correct name for the *Polymorphum rugosum* anamorph of *A. rugosa*, and that *Dichaenopsis notarisii* Paoli is the legitimate binomial of the blastic-phialidic morph (Speer 1980a). Speer advanced convincing arguments but provided no illustrations to support his conclusions. He also failed to cite specimens studied, but did note that "the type material (of *Dichaena*) contains asci and ascospores." However, a fragment of type material (UPS) of *Polymorphum rugosum* (Scleromyceti Sueciae 353) examined by one of us (F.D.) contained only conidiomata. Consequently, we believe the name *Dichaena* is still shrouded in confusion and we tentatively retain the name *Ascodichaena*. We have, however, adopted the names Speer (1980b) applies to the anamorphs, and provide redescriptions of these genera.

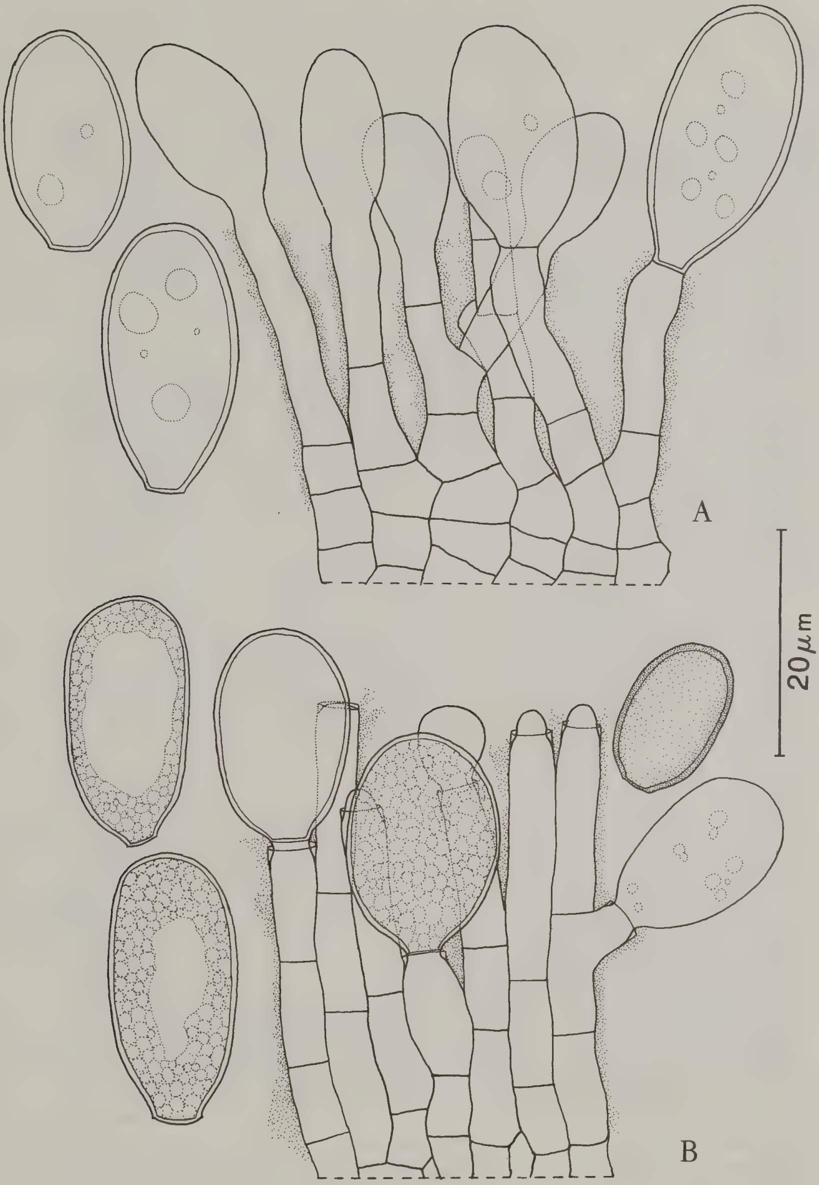
Psilospora Rabenhorst, Hedwigia 1: 107-108 (1856).

Corticolous. Conidiomata gregarious, pulvinate to irregularly hysteriform, black, rugose, carbonaceous; wall composed of exterior *textura globulosa* becoming *textura angularis* toward the interior; dehiscent by irregular or longitudinal rupture of the apical wall, line of dehiscence bordered by inwardly directed sterile processes. Conidiophores lining the entire cavity, septate, branched, hyaline, smooth-walled. Conidia oblong-ellipsoid, rounded above, base truncate, guttulate, hyaline, smooth-walled.

Type anamorph-species: *P. faginea* (Pers.) Rabenh.

Psilospora faginea (Pers.) Rabenh. Fig. 20A.
Hedwigia 1: 107-108 (1856).
≡ *Polymorphum rugosum* (Fr.) D. Hawksworth & Punithal.,
Trans. Brit. Mycol. Soc. 60: 503 (1973).

Corticolous. Conidiomata densely gregarious, erumpent, pulvinate to hysteriform, black, rugose, carbonaceous, unilocular, 500-2000 X 300-500 µm, base immersed in the outer layers of the periderm, dehiscent by irregular to stellate rupture of the apical wall, bordered by pale brown, sterile projections. Wall of black, external *textura globulosa* becoming pale brown interior *textura angularis* subtending a dense hymenium. Conidiophores simple or branched, septate, hyaline, smooth-walled, 15-50 X



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20. A. Psilospora faginea: holoblastic conidiogenesis. 20. B. Dichaenopsis notarisii with blastic-phialidic conidiogenesis. (A. from type material of Polymorphum rugosum; B. from material collected in Ontario, Canada.)

3.5-5 µm, invested in a thin layer of mucilage. Conidiogenous cells holoblastic, subcylindrical to lageniform, hyaline, smooth-walled, 10-25 X 3.5-5 ($\bar{x}$ = 15 X 4) µm. Conidia oblong-ellipsoid, guttulate, apex rounded, base truncate, hyaline, smooth-walled, (12-) 18-25 (-30) X (8-) 10-15 (-17) ($\bar{x}$ = 22 X 12.5) µm.

Habitat: on bark of *Fagus grandifolia*, *F. sylvatica* and *Quercus* sp.

Known distribution: Canada; Europe; U.S.A.

Specimens examined: Teleomorph: Holotype of *A. rugosa*, IMI 209760, H. Butin, Souilly, France, 1976-VI-10; immature ascomata of *A. rugosa*, WAT, F. DiCosmo, Hope Bay, Bruce Co., Ontario, Canada, 1980-VIII-16. Anamorphs: (1) holoblastic; type of *Polymorphum rugosum*, UPS, herb. E. M. Fries, Scleromyceti Sueciae 353; (2) phialidic; IMI 22604, F. DiCosmo, Waterloo, Ont., Canada, 1976-VIII; WAT, F. DiCosmo, Waterloo, Ont., Canada, 1980-VIII-10; WAT, F. DiCosmo, Hope Bay, Bruce Co., Ont., Canada, 1980-VIII-16.

The *Dichaenopsis notarisii* phialidic anamorph of *P. rugosa* is illustrated in Figs. 21-29. This anamorph is morphologically identical to the holoblastic anamorph, but has phialidic conidiogenesis. The conidia of the two anamorphs are also similar. However, those of *D. notarisii* sometimes become pigmented with age.

2. *Cryptomycina* Hoehnel.

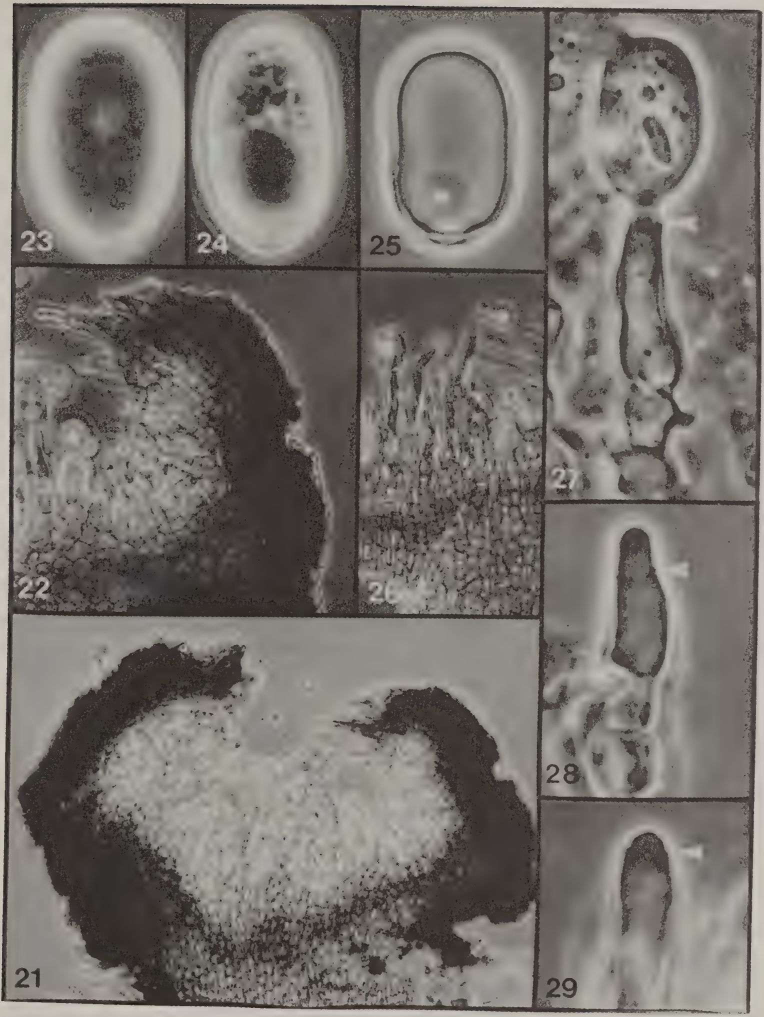
Type species: *Cryptomycina pteridis* (Rebentisch:Fr.) Hoehnel.
Anamorph: *Cryptomycella pteridis* (Kalchbrenner) Hoehnel.

Cryptomycina pteridis, a systemic parasite (Bache-Wiig, 1940) causing 'leaf-roll' disease of *Pteridium aquilinum*, *P. lanuginosum* and *P. latiusculum* has been the subject of several studies (Killian 1918; Hoehnel 1917, 1925; Nannfeldt 1932; Bache-Wiig 1940; Wehmeyer 1966). The biology of *C. pteridis* has been admirably and well documented by Killian (1918) and Bache-Wiig (1940). Wehmeyer (1966) provided a good account of the development of the teleomorph. Regardless of these extensive studies, no author has yet been able to satisfactorily classify the fungus in any known ascomycete family.

Fuckel (1869) first recognized the teleomorph as *Phyllachora pteridis* (Rebent.:Fr.) Fuckel in the Dothideaceae Nitschke. Rehm (1896) transferred it to the Phacidiaceae as *Cryptomyces pteridis* (Rebent.:Fr.) Rehm. Hoehnel (1917) made the fungus the type of his new genus *Cryptomycina*, recognized the sub-epidermal nature of the ascomata, and maintained *C. pteridis* (Rebent.:Fr.) Hoehn. in the Phacidiaceae *sensu* Hoehnel. Nannfeldt (1932) found that the ascomata of *Cryptomycina pteridis* were stromatic and consequently maintained *Cryptomycina* in the Pseudosphaeriales of his Ascoloculares.

Wehmeyer (1966) studied the development of the ascomata. He also found that the anamorph (*Cryptomycella pteridis* (Kalchbrenner) Hoehn.) develops first and persists throughout the entire growing season. He noted that the first conidia formed were less than 10 µm long and 1 µm in diameter, but later-formed conidia were larger. Hoehnel (1925) also recorded smaller and larger conidia. Wehmeyer (1966) was not sure whether or not the microconidia functioned as spermatia. He found that late in the season the conidiophores become thick-walled and pigmented. Wehmeyer noted that it was difficult to place *Cryptomycina* in the classifications advanced by Nannfeldt (1932), Miller (1949), and Luttrell (1955), and retained it in the Phacidiales, but noted the "...dothideaceous..." development of the ascomata.

The following observations, derived from fresh specimens and herbarium material of *C. pteridis*, agree with those of Bache-Wiig (1940), Killian (1918) and Wehmeyer (1966) in most respects.



Dichaenopsis notarisii ex WAT. 21. V. S. of conidioma. x 125. 22. Detail of excipulum of conidioma. x 310. 23, 24. Conidia. x 1280. 25. 'Ghost' conidium, showing thick outer wall. x 1280. 26. Detail of subhymenium. x 310. 27-29. Blastic-phialidic conidiogenous cells. x 1280.

Cryptomycina pteridis (Rebentisch:Fr.) Hoehnel, Annls. Mycol. 15: 321-322 (1917).
≡ *Sphaeria pteridis* Rebentisch, Prodrom. flor. neomarch., 224: Fig. 16 (1804).
≡ *Xyloma pteridis* (Rebentisch) Fr., Observ. Mycol. p. 200 (1817).
≡ *Dothidea pteridis* (Rebentisch):Fr., Syst. Mycol. 2: 555 (1823).
(sanctioned, ICBN, Art. 13.1 (f)).
≡ *Phyllachora pteridis* (Rebentisch:Fr.) Fuckel, Symb. Mycol., p. 218 (1869).
≡ *Cryptomyces pteridis* (Rebentisch:Fr) Rehm, Ascomyceten (*In* Die Pilze, Deutsch. Oester. Schweiz 3(1): 107 (1896).

Foliicolous on dead fern fronds. Ascomata hypophyllous, gregarious to densely crowded and confluent, circular to irregularly elongate in outline, pulvinate, black, initially immersed, intra-epidermal to subepidermal, ultimately splitting open irregularly or longitudinally above to expose the hymenium, 500-3000 X 300-600 µm; overlying fungal tissue composed of brown, thick-walled, pseudoparenchymatous cells forming a *textura globulosa* up to 60 µm thick, becoming hyaline toward the interior, innermost cells hyaline with rounded ends and invested in a thin layer of mucilage. Hymenium up to 65 µm thick, of asci, and rarely with short hyphal elements. Asci club-shaped, octosporous, 60-65 X 10-12 ($\bar{x}$ = 62 X 11) µm, with an amyloid (I^+) apical dehiscence ring. Ascospores uniseriate or biseriate, ellipsoid, guttulate, hyaline, smooth-walled, (7.5-) 8-10 X 5 (-6) ($\bar{x}$ = 8.5 X 5.5) µm, mean length/width ratio = 1.5:1.

The initial sign of infection is the convex arching of the pinnules (when viewed from above), and a subsequent discolouration of the affected parts. During the Spring and early Summer, conidiomata of *Cryptomycella pteridis* are initiated. The macroconidia appear in discrete, hypophyllous, acervuloid conidiomata (Figs. 30, 31), and microconidia appear later in similar, but smaller structures (Fig. 32). Ultimately, in late Summer and Autumn, ascomata are initiated. The complete life-cycle of *Cryptomycina pteridis* and its anamorphs is presented in Fig. 45.

The ascomata can arise from the same stroma in which the macroconidia develop, or they may arise in discrete lesions. The incipient ascomata are composed of isodiametric, pseudoparenchymatous cells forming a dark brown *textura globulosa*. The internal, central palisade is meristematic. According to Wehmeyer (1966) the ascogenous cells are clearly visible before differentiation of the fungal stroma. Trichogynes emerge through the stomata of the host; presumably microconidia or macroconidia will be transferred to these receptive hyphae.

The meristematic region begins to show disintegration after 3 weeks' growth in the field, and the ascogenous hyphae develop from the meristematic cells. Wehmeyer (*op. cit.*) found that asci developed directly from the fragmented meristematic cells, without the intervention of croziers. He also found that nuclear fusion did not occur until the infected frond became detached or died and the teleomorph became saprophytic. Apparently, the teleomorph overwinters in a diploid condition. The incipient asci enlarge and become club-shaped during the winter months.

With the advent of spring 8 haploid nuclei are delimited within each ascus. The uninucleate ascospores mature in summer and are released during June and August. It is presumed that these ascospores are capable of infecting young fern sporophytes.

Several important features exclude *Cryptomycina pteridis* from the Phacidiaceae *sensu* DiCosmo, Nag Raj & Kendrick. The microanatomy of *C. pteridis* is uncharacteristic of *Phacidium* and *Lophophacidium*. In *C. pteridis* the ascoma is built of isodiametric, pseudoparenchymatous cells forming a *textura globulosa*. The inoperculate asci arise directly from the fragmented meristematic cells of the stroma, apparently without the intervention of croziers, though we could not confirm this. Sterile, non-septate hyphal elements may sometimes be found intermixed with the asci. The asci of *C. pteridis* are club-shaped and have a thick apical wall which is pierced by an amyloid (I^+) dehiscence ring.

The members of the Phacidiaceae *sensu* DiCosmo, Nag Raj & Kendrick, (i.e. species of *Phacidium* and *Lophophacidium*) all produce true paraphyses. The inoperculate asci of these species arise from a usually differentiated subhymenium and are produced from a proliferating system of croziers. The ascus apex is thin-walled and pierced by a delicate (I^+) dehiscence ring.

In our opinion, retention of an anomalous taxon such as *C. pteridis* in the Phacidiaceae would weaken the familial concept that has been developed through microanatomical, developmental and life-cycle studies. We therefore exclude *Cryptomycina* from the Phacidiaceae *sensu* DiCosmo, Nag Raj & Kendrick, but can suggest no suitable niche for this taxon.

It has already been pointed out that Hoehnel (1925) and Wehmeyer (1966) found that *Cryptomycina pteridis* anam. *Cryptomycella pteridis* produces conidia of two types. We have also observed these. Not surprisingly, the earlier authors did not record the developmental and morphological peculiarities of the microconidia. In view of this new information we propose to amend the circumscription of *Cryptomycella* and *C. pteridis* to include the microconidial synanamorph (Figs. 37-44).

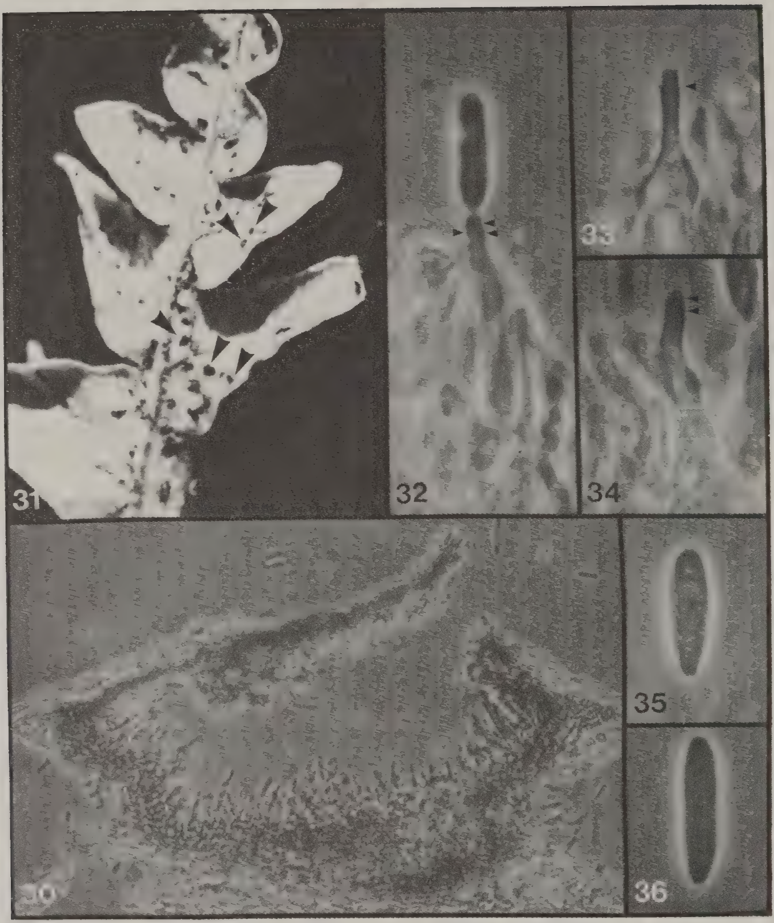
Cryptomycella Hoehnel char. amend. DiCosmo, Nag Raj & Kendrick.
Hoehnel, in Mitt. Bot. Inst. Techn. Hochsch. Wien 2: 48 (1925).

Foliicolous on living fern fronds. Conidiomata acervular, stromatic, hypophyllous, scattered or gregarious, often confluent, intraepidermal to subepidermal, dark-brown to black, irregular in outline, rupturing irregularly above; wall of *textura globulosa*. Conidiophores arising from the innermost cells of the basal stroma, branched or simple, smooth-walled and invested in a mucilaginous matrix. Conidiogenous cells phialides of two types, some producing macroconidia, others producing microconidia, terete, integrated or not, proliferating percurrently several times. Macroconidia fusiform with truncate base, to navicular, hyaline, smooth-walled, and collecting in mucilaginous droplets. Microconidia produced with macroconidia or in separate acervuloid structures, club-shaped, end truncate, bearing an irregular, evanescent apical mucilaginous appendage and an irregular to funnel-shaped mucilaginous basal appendage.

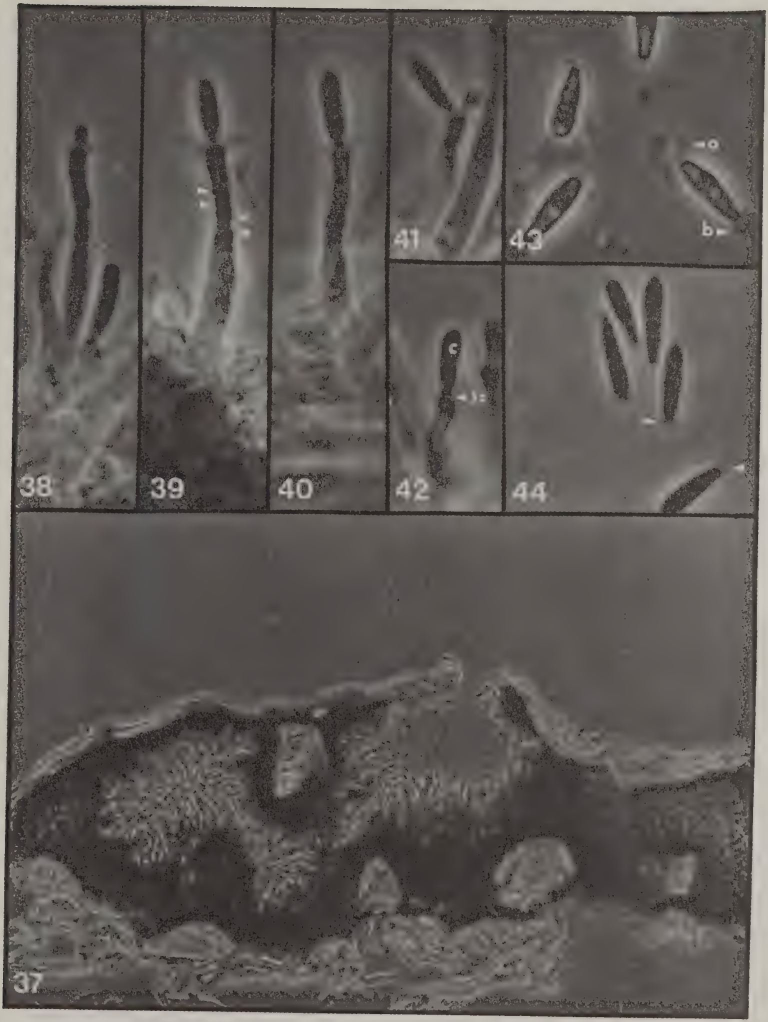
Type Anamorph-species: *Cryptomycella pteridis* (Kalchb.) Hoehn.

Cryptomycella pteridis (Kalchbr.) Hoehnel char. emend. DiCosmo, Nag Raj & Kendrick. Figs. 30-36.
Hoehnel, in Mitt. Bot. Inst. Techn. Hochsch. Wien 2: 48 (1925).
≡ *Fusidium pteridis* Kalchbrenner, Bot. Zeit., 19: 296 (1861).
= *Gloeosporium obtengens* Syd., in Syd. & Syd., Annls. Mycol. 2: 172 (1904).

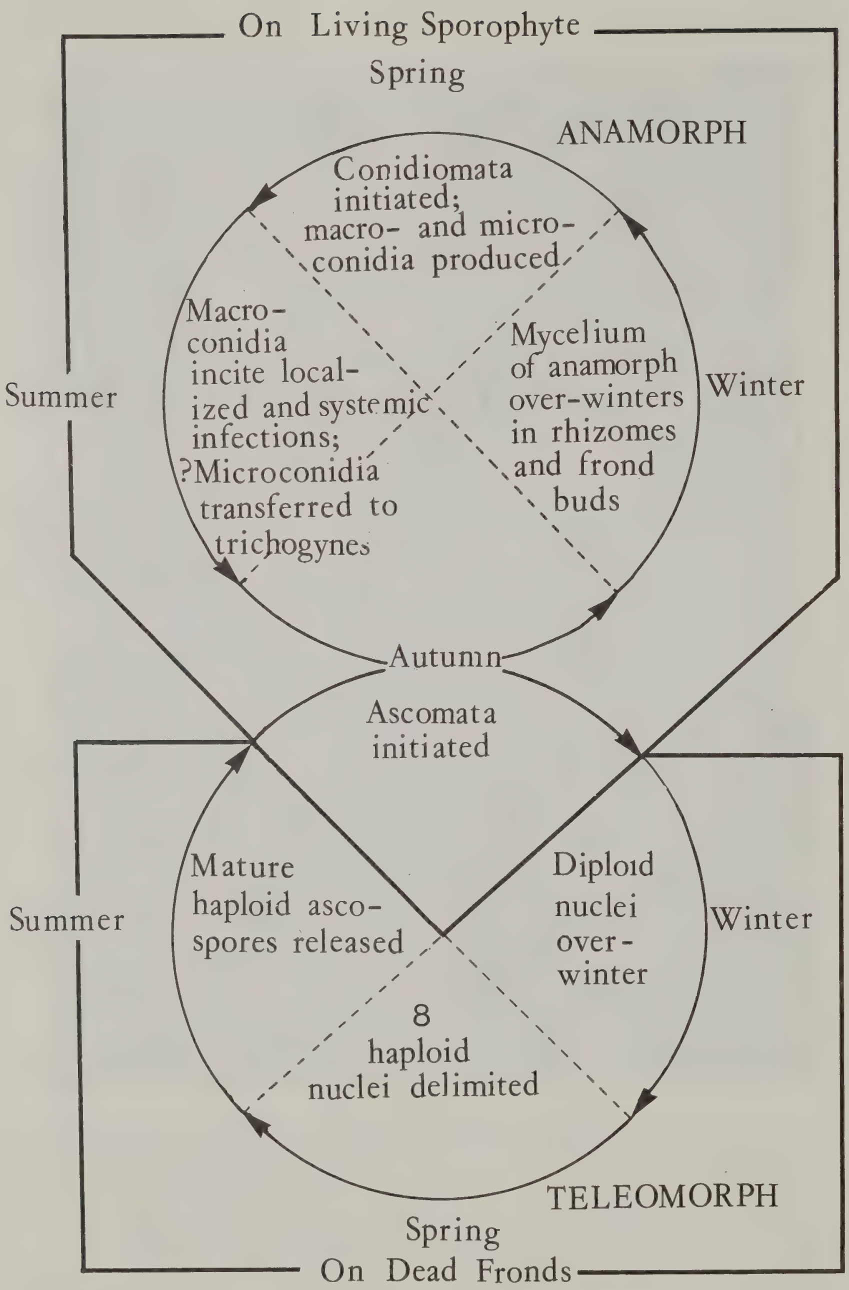
Foliicolous on living fern fronds. Conidiomata acervular, strictly hypophyllous, scattered to gregarious, often confluent, initially immersed, subepidermal, raising the overlying host tissue into dark brown to black, subcircular to elongated, irregular swellings, 500-2000 µm, rupturing irregularly above; basal stroma of brown to dark brown, thick-walled cells forming a *textura globulosa*, golden-brown toward the interior, darkest



Cryptomycella pteridis anam. of *Cryptomycina pteridis* ex herb. FH, herb. Hoehnel except 31. 30. V.S. of conidioma. x 205. 31. Detail of infected frond, arrow-heads indicate conidiomata (material in WAT). x 6.5. 32-34. Conidiogenous cells, arrow-heads denote percurrent proliferations. x 1280. 35, 36. Conidia. x 1280. See also microconidial synanamorph (Figs. 37-44).



Microconidial anamorph of *Cryptomycina pteridis* (DAOM 5831). 37. V.S. of conidioma. x 205. 38-40. Conidiogenous cells with percurrent proliferations. x 1280. 41. Conidiogenous cell with a young microconidium and a more mature microconidium being set free. 42. Conidiogenous cell with a young microconidium (c) and separating cell (sc). x 1280. 43. Microconidia in distilled water with apical (a) and basal appendages (b). x 1280. 44. Microconidia in lactic acid: arrow-heads indicate basal appendages; apical appendages not visible. x 1280. See also *Cryptomycella pteridis* synanamorph (Figs. 30-36).


On Living Sporophyte
Spring
ANAMORPH
Conidiomata initiated; macro- and micro-conidia produced
Macro-conidia incite localized and systemic infections; ?Microconidia transferred to trichogynes
Mycelium of anamorph over-winters in rhizomes and frond buds
Summer
Winter
Autumn
Ascomata initiated
Mature haploid ascospores released
Diploid nuclei over-winter
8 haploid nuclei delimited
Summer
Winter
TELEOMORPH
Spring
On Dead Fronds

Life-cycle strategy of Cryptomycina pteridis basal stroma, branched or simple, septate, hyaline above, subhyaline to pale yellow below, smooth-walled, (18-)20-30(-32) X 3(-3.5) ($\bar{x}$ = 25 X 3) µm, invested in a mucilaginous matrix. Conidiogenous cells phialides, terete, integrated or not, hyaline, smooth-walled, (7-) 8-15 X 2-3 ($\bar{x}$ = 10 X 2.5) µm, proliferating percurrently several times, and invested in mucilage. Conidia blastic-phialidic, non-septate, fusiform with truncate bases to navicular, guttulate, hyaline, smooth-walled, 10-25 X (2.5-) 3-4 ($\bar{x}$ = 16 X 3) µm, mean length/width ratio = 5:1, collecting in a mucilaginous droplet around the area of dehiscence. Microconidia produced with the macroconidia or in separate acervuloid structures 300-500 µm diam. (Figs. 37-44). Conidiophores producing microconidia 15-30 X 1.5-2.5 µm. Conidiogenous cells producing microconidia are phialides, 10-20 X 1-2 ($\bar{x}$ = 14 X 1.5) µm, proliferating percurrently several times. Microconidia club-shaped, non-septate, guttulate, hyaline, smooth-walled, 5-10 X (1.5-) 2 ($\bar{x}$ = 8 X 2) µm, mean length/width ratio = 4:1, bearing an irregular apical mucilaginous appendage and a funnel-shaped, mucilaginous basal appendage, which is the remnant of a separating cell between the conidiogenous cell and the conidium body.

Habitat: Teleomorph on dead fern fronds, anamorph on living fern fronds of *Pteridium aquilinum*, *P. lanuginosum*, and *P. latiusculum*.

Known distribution: Canada; Europe; Russia; U.S.A.

Specimens examined: Canada: *British Columbia*: DAOM 5813, H. Murray & J.W. Eastham, Crawford Bay, Kootenay, 1940-III-07; DAOM 5389, W. Newton, Saanich, 1938-IX-05; DAOM 5150, C. G. Riley & I. L. Conners, Cowichan, 1930-VIII-04; DAOM 5147; DAOM 118198, H. Murray, Crawford Bay, 1939-X; DAOM 159749, W. J. Cody, Mt. Revelstoke Nat. Pk., 1976-VII-15; *New Brunswick*: DAOM 169416, D. Munro, E. of St. Louis de Kent, Kouchibougouac Nat. Pk., 1978-VIII-18; *Nova Scotia*: DAOM 35039, D. Creelman, Sunken Lake, Kings, 1952-VI-19; DAOM 115178 ex TRTC 41293, R. F. Cain, Broad Cove, Cape Breton, 1963-VIII-12; DAOM 54348, D. Creelman, Port Clyde, 1953-VIII-06; DAOM 19519, H. A. Senn, Green Cove, Victoria, Cape Breton, 1939-VIII-19; *Ontario*: WAT, Algonquin Park FD/80, F. DiCosmo & W. B. Kendrick, Algonquin Park, 1980-IX-09; DAOM 75847, G. D. Darker, Cattle Is., L. Timagami, 1923-VII-23; DAOM 140098, J. A. Parmelee & J. Dougan, Sioux Narrows, Kenora, 1971-VIII-28; DAOM 14683, R. C. Hosie, Michiparten, 1938-IX-07; DAOM 5696, W. N. Denike, Ingolf, 1938-VIII-15; DAOM 86415 ex TRTC 1207, Cattle Is., L. Timagami; DAOM 26667, J. A. Parmelee, Chalk R., 1951-VII-17; DAOM 97400, G. D. Darker, Katrine, Parry Sound Dist., 1956-VIII-31; DAOM 155242, G. R. Bisby, Minaki, 1924-IX-01; DAOM 115177, R. F. Cain, Agawa Bay, Algoma Dist., 1961-VI-18; DAOM 145428, C. E. Garton, Black Sturgeon Res. Stn., Black Sturgeon L. *Prince Edward Island*: DAOM 144439, G. C. Warren, N. River, 1905; DAOM 14440, G. C. Warren, same as DAOM 144439; *Quebec*: DAOM 63852, J. A. Parmelee, W. of Mt. Joli; DAOM 19668, A. Payette, Quai de la Riv. Quelle, Kamouraska Co., 1947-VIII-05; DAOM 89814, W. B. & G. V. Cooke, Anse au Griffon, Gaspe Pen., 1959-VII-13; DAOM 2481, J. H. Gussow, Mt. Murnet, 1943-VII- 9; DAOM 12096, E. Campagna, St. Elzear de Bonaventure, 1936-VII-11; DAOM 123096, M. Anselme, Beauceville, 1943-VII-17; DAOM 10219, M. Anselme, Eastman Shefford Co., 1946-VIII-30; DAOM 2804, J. Adams, Bic, 1935-VIII-23; DAOM 12252, M. Anselme, Disraeli, 1942-VII; DAOM 145113, C. Hamel & S. Brisson, Mt. 'Big Ham', Canton and d'Ham Sud, Wolfe Co., 1968-VIII-16; DAOM 7660, M. Anselme, Point au Pic, Murray Bay, 1941-VIII-26; DAOM 150547, W. G. Dore & I. L. Conners, Dauford Lake, Gatineau Co., 1934-VII-23; DAOM 145246, Rolland-Germain, St. Adolphe d'Howard, Argenteuil, 1967-VIII-19; Europe: *Austria*: FH ex Herb. Hoehnel 4557, F. Hoehnel, Tirol, 1901-VIII-29; also as 4557, Hoehnel, Tirol, 1903-VII-24; Rehm, Ascomyceten no. 522b in Herb. Hoehnel sub 4557; DAOM 14444, Exsiccata Austro-Hungarica no. 2375, Doerfler; DAOM 119861, Herbier Barbey-Boissier no. 710, L. Fuckel, 1894; DAOM 119862, H. Barbey-Boissier no. 772, J. Mueller, 1852-VIII-02; DAOM 387118, A. Kerner; *Finland*: DAOM 107862, H. Raivainen, 1963-IX-08; DAOM 107863, B. & L. Fagerstroem, Aemmaenaeki, 1963-VII-01; DAOM, T. Freindenfelt, 1893-VIII-18; DAOM 119510, P. Alanko, 1965-VII-17; DAOM 119457, L. Fagerstroem, 1963-VII-05;

DAOM 134767, V. Kujala, Punkarju, 1945-VII-23; DAOM 159820, L. Fagerstroem, Karelia, Vehkalahti, 1975-VIII-14; DAOM 91631, L. & H. Raivaiven, 1958-II-01; DAOM 110043, T. Ulvinen, 60°16'N, 1961-VII-09; DAOM 92447 & 92449, L. E. Kari, Kaarina, Kurala, 1923-IX-11; *France*: DAOM 58823, J. B. Mougeot & C. Nestler, Stirpes Cryptogamae Vogeso-Rhenanae Fasc. X, no. 980, 1833; *Hungary*: DAOM 144455, S. Magoesy-Dietz, Nagygajdos, 1906-VIII; *Norway*: DAOM 166465, F. & E. Eckblad, 1977-VIII-21; *Russia*: DAOM 120423, K. Starzs, Vidzeme, 1924-VII-13; *Sweden*: DAOM 11584, H. Mortensen, 1971-VII-26; DAOM 87192, J. A. Nannfeldt, Boda Crown For., 1953-VII-29; DAOM 56049, J. Lundberg, Vaestergoetland, 1956-VIII-05; DAOM 63584, G. V. Schotte, Allhegona, Bullersta, 1892-VIII (same as DAOM 144443); DAOM 63569, H. Hesselman, Osterguetland, 1891-VIII; DAOM 144445, L. Rommell, Stockholm, 1890-V-21; DAOM 144449, J. W. Hamner, 1892-VIII; DAOM 144447, A. Berg & G. Lang, 1893-VII (same as DAOM 144448); DAOM 14453, E. Ljungstroem, Boekebergsslaett, 1881-VIII-04; *U.S.A.*: IMI 21776, G. M. Grant, Maryville, Washington, 1922-VIII; DAOM 37117, A. B. Seymour & F. S. Earle Economic Fungi no. 400, Seymour, Thompson Falls, Montana, 1884-IX-19; DAOM 167297, W. B. & G. V. Cooke, Olympic Nat. Park, Jefferson Co., Washington, 1970-IX-07; DAOM 81645, Williams & Griffiths, Missoula, Montana, 1898-IX-10; DAOM 144442, J. J. David, Raine, Wisconsin, 1896-VII-05; in Herb. ZT ex herb. Mueller, Mains, Michigan, 1933-VI-16; FH, E. B. Copeland, Mt. Eddy, Siskiyon Co., Calif., 1903-VIII. Other collections examined: IMI 33154, Petrak Mycotheca generalis no. 1772, J. Bornmueller, Thueringen, Germany, 1943-VIII.

Davis (1924) and Gilman & Archer (1929) have provided extensive synonymies for *Cryptomycella pteridis*. Undoubtedly, this very common coelomycete has been collected and described many times in many different countries by various authors. A thorough search in world herbaria would surely reveal many unfamiliar names for this fungus.

3. *Darkera* Whitney, Reid & Pirozynski

Type species: *D. parca* Whitney, Reid & Pirozynski.
Anamorph: *Tiarosporella parca* Whitney, Reid & Pirozynski.

Whitney, Reid & Pirozynski (1975) introduced *Darkera* for "...an unusual phacidiaceous..." fungus found on diseased conifer leaves. Two species, *D. abietis* Whitney, Reid & Pirozynski and *D. parca*, were described at that time. *Darkera* was assigned to the Phacidiales mainly on the basis of the morphologcal characteristics of the ascomata. The ascomata are initiated within a stroma which ruptures irregularly at maturity to expose a dense hymenium of asci and paraphyses. Whitney et al. (1975) noted that *Darkera* could be referred to the Phacidiaceae but for the peculiar mode of ascus dehiscence: the ascus apex tears irregularly to liberate the ascospores.

We consider the Phacidiaceae to be united by several shared characteristics (DiCosmo, Nag Raj, & Kendrick 1983): 1) the ascomata are black externally with the covering layer composed of regularly oriented *textura globulosa* that terminates in periphysoids immersed in a mucilaginous matrix, 2) the hymenium is composed of asci and true paraphyses that frequently anastomose, 3) the ascal apices have an amyloid (I^{+}) dehiscence ring, 4) the hyaline to subhyaline ascospores never have gelatinous appendages or coats, and 5) the anamorphs have blastic-phialidic conidiogenesis and the conidia bear mucilaginous apical appendages.

In *D. abietis* and *D. parca* the ascal apices are relatively thin-walled and have no discernible pore. The ascus apex gives no amyloid reaction when rehydrated in distilled water or 2% KOH solution and mounted in Melzer's reagent. This confirms the careful observations made by Whitney et al. (1975).

The anamorphs of *D. abietis* and *D. parca* were cited as *Tiarosporella abietis* Whitney, Reid & Pirozynski and *T. parca* Whitney, Reid & Pirozynski, respectively (Whitney et al. 1975). In 1975, Whitney et al. drew attention to the "...considerable similarity ..." between *Tiarosporella* Hoehnel and *Ceuthospora* Greville. The authors believed that *Ceuthospora* spp. were conidial states of "*Phacidium*, its segregates, and of *Coccomyces*." Such assertions are misleading and no doubt based on literature published prior to this study. We know of no *Coccomyces* spp. with *Ceuthospora* anamorphs (DiCosmo pers. obs.; Sherwood 1980). The similarity between species of *Ceuthospora* and *Tiarosporella* is limited to their conidia, which in both cases bear irregular to funnel-shaped, mucilaginous appendages.

Whitney, Reid & Pirozynski (1975) provided lucid and well-illustrated documentation of *Darkera*. They presented some convincing evidence in support of the "phacidiaceous" nature of the genus. However, *Darkera* may be related to *Rhabdocline* Sydow & Petrak (Sydow & Petrak 1922). Our studies of *Darkera* spp. are largely in agreement with those of Whitney, Reid & Pirozynski (1975). However, we have noted some previously undetected features which are presented here.

KEY TO THE SPECIES OF *DARKERA*

Ascomata on *Abies* sp.; ascospores 19-26 X 9-13 µm,
  mean length/width ratio = 2:1........................*D. abietis* (a).
Ascomata on *Picea* sp.; ascospores 15-32 X 8-15 µm,
  mean length/width ratio = 2.4:1........................*D. parca* (b).

a) *Darkera abietis* Whitney, Reid & Pirozynski Can. J. Botany 53: 3052-3053 (1975)

Anamorph: *Tiarosporella abietis* Whitney, Reid & Pirozynski.

Immersed mycelium of branched, septate, hyaline, smooth-walled hyphae 1.5-3 µm wide, forming a *textura intricata*, hyphae widely spaced and immersed in a mucilaginous matrix.

Foliicolous. Ascomata hypophyllous, on either side of the midrib, scattered to gregarious, sometimes confluent, black, circular, subcircular or irregular, up to 100 X 500 µm, immersed, subepidermal, raising the host tissue into swellings, ultimately splitting above; overlying fungus tissue of dark brown outer pseudoparenchymatous cells with gelatinizing outer walls, and pale brown inner pseudoparenchyma of *textura epidermoidea*, sometimes terminating in short, rounded projections. Hymenium plane, pale yellow, up to 110 µm thick; subhymenium pale yellow-brown to brown, of *textura epidermoidea* (individual cells with gelatinizing outer walls) up to 15 um thick. Asci club-shaped, 8-spored, flattened in the area of the non-amyloid (I^-) apex, (87-) 90-100 (-115) X (16-) 17-20 (-21) ($\bar{x}$ = 22 X 10.5) µm, mean length/width ratio = 2.1:1. Paraphyses usually simple, occasionally branched, septate, with slightly swollen apices, hyaline, smooth-walled, often anastomosing, up to 115 µm long, 1.0-2.5 µm wide, invested in mucilage.

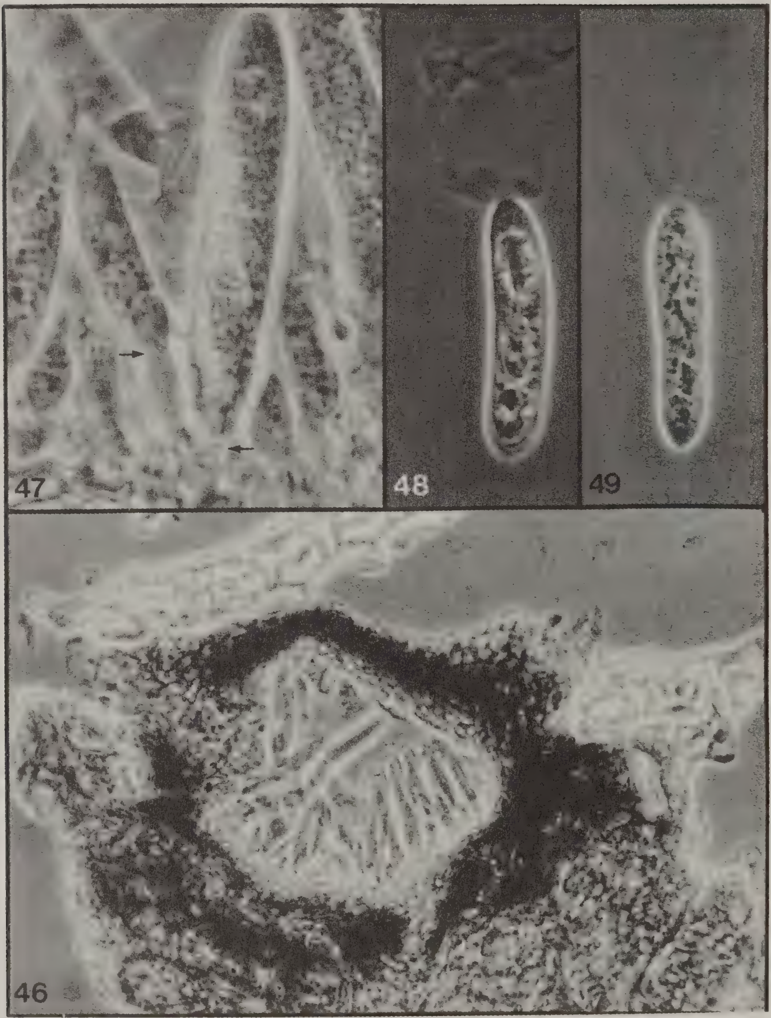
Habitat: on leaves of *Abies balsamea*.

Known distribution: Canada (Manitoba, Ontario); U.S.A. (Oregon).

Specimen examined: DAOM 145406a, Holotype, Jansons, Griffins & Lynn, Rod Lake, Geraldton Dist., Ontario, Canada, 1961-VII-22.

Tiarosporella abietis Whitney, Reid & Pirozynski Figs. 46-49.
Can. J. Botany 53: 3055 (1975).
= *Macrophoma parca* Ell. & Ev., *nomen nudum*, North American Fungi, 2nd series No. 2159 (1889) *non M. parca* (Berk. & Br.) Berl. & Vogl., Syll. Fung., Additamenta ad Vol. I-VI: 313 (1886).

Foliicolous. Conidiomata pycnidioid, mostly epiphyllous, sometimes



Tiarosporella abietis anamorph of *Darkera abietis*. 46. V.S. of a conidioma. x 205. 47. Detail of conidiogenous cells and conidia, arrows indicate point of secession. x 1600. 48, 49. Mature conidia. x 1280.

amphigenous, scattered to gregarious, unilocular, glabrous, subglobose to ovoid, brown, no definite ostiole, up to 500 µm long and 300 µm wide, immersed, subepidermal, raising the epidermis into dark brown swellings, then piercing it by a lateral, straight or curved neck, up to 25 µm wide, wall of dark brown textura globulosa above, less pigmented below. Conidiogenous cells usually confined to the basal layer, lageniform to ampulliform, hyaline, smooth-walled, 5-10 X 3-6 ($\bar{x}$ = 7.5 X 3.5) µm, invested in mucilage. Conidia holoblastic, non-septate, subcylindrical, straight or curved, swollen slightly toward the apex, rounded above (ghost cells show an apical thickening), base truncate and often bearing a minute marginal frill, guttulate, hyaline, smooth-walled, (29-) 36-42 X (7.5-) 8-9 (-10) ($\bar{x}$ = 39 X 8.5) µm, mean length/width ratio = 4.6:1, invested in a mucilaginous sheath which everts at maturity to form an irregularly-shaped apical appendage.

Habitat: on leaves of Abies balsamea, A. concolor, and A. lasiocarpa.

Known distribution: Canada (Alberta, Ontario, Yukon Territory); U.S.A. (Oregon); Germany.

Specimen examined: DAOM 14506b, Holotype, Jansons, Griffin & Lynn, Rod Lake, Geraldton Dist., Ontario, Canada, 1961-VII-22.

b) Darkera parca Whitney, Reid & Pirozynski Figs. 50-53.
Can. J. Botany 53: 3053 (1975).

Anamorph: Tiarosporella parca (Berk. & Br.) Whitney, Reid & Pirozynski.

Immersed mycelium of branched, septate, hyaline, smooth-walled hyphae, 1.5-2.5 µm wide, forming a textura intricata, hyphae widely spaced and immersed in a mucilaginous matrix.

Foliicolous. Ascomata amphigenous, scattered to gregarious, sometimes confluent, black, elliptical to elongate-elliptical, up to 2000 µm long and 225-350 µm wide, immersed, subhypodermal, raising the epidermis into swellings, then splitting the overlying fungus tissue longitudinally; covering layer of dark brown textura epidermoidea, paler toward the interior. Hymenium plane, up to 120 µm thick; subhymenium pale yellow to pale brown, of pseudoparenchymatous cells with gelatinizing outer walls and forming a textura angularis. Asci club-shaped, 8-spored, flattened slightly in the area of the non-amyloid (I^-) apex (70-) 75-110 (-120) X (16-) 18-21 (-25) ($\bar{x}$ = 95 X 20.5) µm. Ascospores biseriate, ellipsoid to subreniform, unicellular, sometimes guttulate, at first hyaline then pale brown, smooth-walled, (15-) 17-25 (-32) X 8-12 (-15) ($\bar{x}$ = 23 X 10) µm, mean length/width ratio = 2.4:1. Paraphyses simple or branched, septate, with a slightly swollen apex, hyaline, smooth-walled, up to 110 µm long and 1-2.5 µm wide, frequently anastomosing and invested in mucilage.

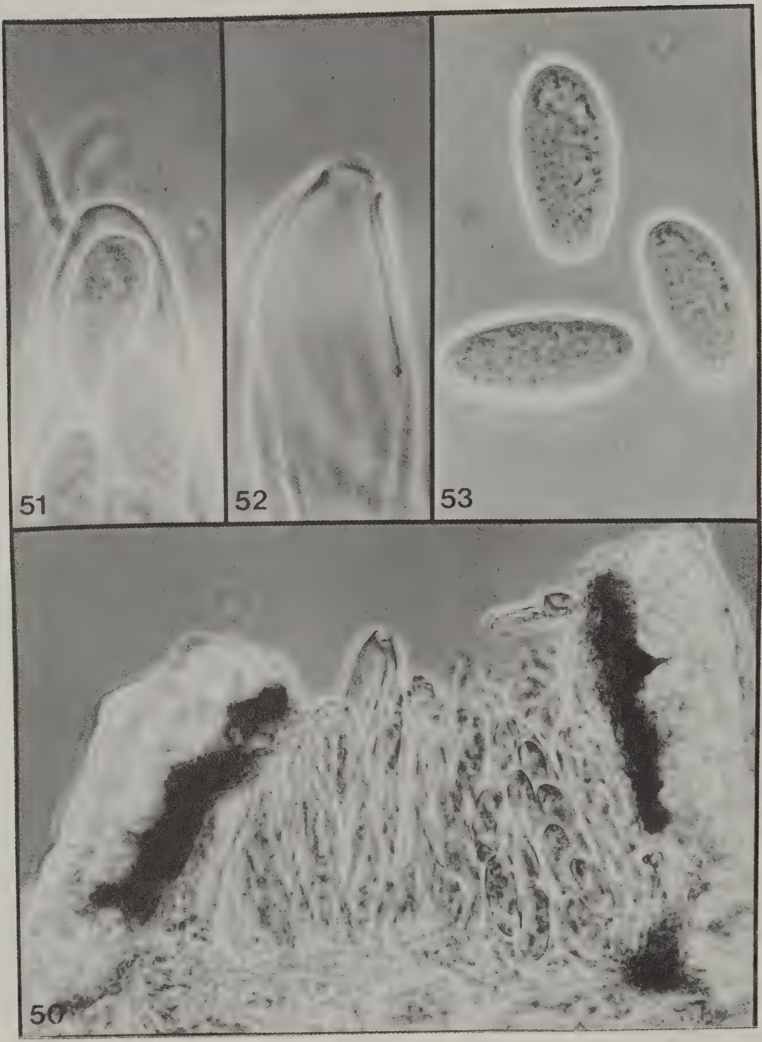
Habitat: on leaves of Picea glauca.

Known distribution: Canada (Alberta); Czechoslovakia.

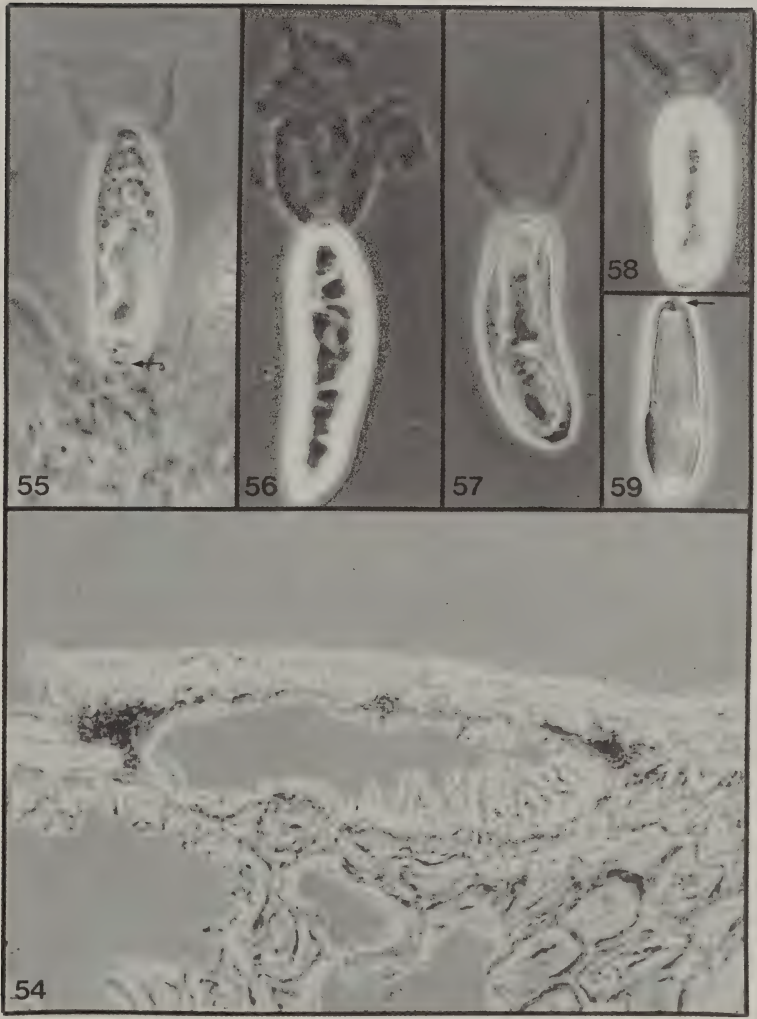
Specimens examined: DAOM 145413, holotype, J. Petty, 68 mi. S. W. of Wembley, Two Lakes Rd., Alberta, Canada, 1965-VII-04; DAOM 145413 ex CFB 7829, G. Smith, 68 mi. S.W. of Wembley, Two Lakes Rd., Alberta, Canada, 1965-VII-04.

Tiarosporella parca (Berk. & Br.) Whitney, Reid & Pirozynski Figs. 54-57.
Can. J. Botany 53: 3055-3056 (1975).
≡ Sphaeropsis parca Berk. & Br., Ann. Mag. Nat. Hist. ser. 2(5): 375 (1850).
≡ Phoma parca (Berk. & Br.) Sacc., Syll. Fung. 3: 100 (1884).
≡ Macrophoma parca (Berk. & Br.) Berl. & Vogl. Syll.Fung., Additamenta ad Vol. I-VI: 313 (1886) non Macrophoma parca Ell. & Ev. nomen nudum.

Foliicolous. Conidiomata amphigenous, scattered, unilocular, glabrous,



Darkera parca. 50. V.S. of ascoma. x 800. 51. Ascus apex. x 1280. 52. Dehiscent ascus. x 1280. 53. Ascospores. x 1280.



Tiarosporella parca anam. of Darkera parca. 54. V.S. conidioma. x 320. 55. Conidiogenous cells, arrow shows point of secession. x 1280. 55-58. Mature conidia. x 1280. 59. 'Ghost' conidium, arrow indicates thick-walled apex. x 1280.

brown above, hyaline below, elliptical to elongate-elliptical, up to 400 µm long and 85 µm high, subhypodermal, raising the epidermis into dark brown swellings, then piercing the epidermis by a lateral, straight or curved neck up to 40 µm wide, and composed of branched, septate, smooth-walled hyphae, brown to dark brown above, hyaline to subhyaline below, compacted to form a *textura epidermoidea* up to 22 µm thick below and 8 µm thick above. Conidiogenous cells sometimes entirely lining the locule, but usually confined to the basal stratum, ampulliform to lageniform, hyaline, smooth-walled, (5-) 7-12 X (-15) X 3-5 ($\bar{x}$ = 9.5 X 4) µm, invested in mucilage. Conidia holoblastic, non-septate, subcylindrical, straight orslightly curved, a little swollen toward the rounded apex, base truncate, often bearing a marginal frill, hyaline to pale yellow, smooth-walled, (29-) 35-43 (-54) X 9-12 ($\bar{x}$ = 39 X 11) µm, mean length/width ratio = 3.5:1, invested in a mucilaginous sheath which becomes everted at maturity to form an irregular appendage.

Habitat: on leaves of *Picea abies*, *P*. *englemanni*, *P*. *glauca*.

Known distribution: Canada (Alberta); England; Czechoslovakia.

Specimens examined: DAOM 145413b, J. Petty, 68 mi. S. W. of Wembley, Two Lakes Rd., Alberta, Canada, 1965-VII-04; DAOM 145413 ex CFB-7829, G. J. Smith, 68 mi. S. W. of Wembley, Two Lakes Rd., Alberta, Canada, 1965-VII-04.

The proper classification of *Darkera* seems difficult. *D*. *abietis* and *D*. *parca* seem to have some characteristics of the Hemiphacidiaceae (Korf 1962) and the Phacidiaceae. The Hemiphacidiaceae are recognized by the absence of an upper stromatic covering layer. Sometimes a roof of hyaline, septate hyphae is present, but the excipulum is poorly developed. The asci may have non-amyloid apices (Hemiphacideae), or amyloid dehiscence rings (Sarcotrochilieae). Using these criteria, *Darkera* is referable to the Hemiphacidieae, and may be closely related to *Rhabdocline*. However, *D*. *parca* has a stromatic covering which has been considered characteristic of the Phacidiaceae *sensu lato*. The organization of the roof of *D*. *parca* is not characteristic of the Phacidiaceae *sensu* DiCosmo, Nag Raj & Kendrick. The cells of the stroma are not vertically oriented as in *Phacidium* spp. The asci of *D*. *abietis* and *D*. *parca* have a non-amyloid (I^-), thin-walled apex, which resembles the ascus apex of *Rhabdocline pseudotsugae* Sydow & Petrak subsp. *pseudotsugae* (Sydow & Petrak 1922; Parker & Reid 1969). The *Tiarosporella* anamorphs of *Darkera* spp. do not seem closely related to the *Rhabdogloeum* anamorphs of *Rhabdocline* spp. (see discussion of *Rhabdocline* for details of *Rhabdogloeum*). These features argue against the relationship of *Darkera* to *Rhabdocline* and the Hemiphacidiaceae.

Experience indicates that as a general rule, the anamorphs are nearly equal to the teleomorphs in classificatory value. Some 'natural' groupings are much more clearly expressed by anamorphs (Hennebert & Bellemère 1979; Kendrick & DiCosmo 1979). Such is the case in the Phacidiaceae *sensu* DiCosmo, Nag Raj & Kendrick. Definite cultural correlations between anamorphs and teleomorphs are needed for the *Darkera* and *Rhabdocline* complexes.

4. *Didymascella* Maire & Saccardo in Maire, Dumee & Lutz, Bull. Soc. Bot. France 4(1): Sept. 1903.
≡ *Didymascella* Maire & Saccardo, Annls. Mycol. 1: 418 (1903).
≡ *Keithia* Saccardo, Syll. Fung. 10: 49-50 (1892) (*non Keithia* Bentham, 1834 (Labiatae)).

Type species: *D*. *oxycedri* Maire & Sacc., in Maire, Dumee & Lutz.

Saccardo (1892) introduced the name *Keithia* Sacc. for *Phacidium tetrasporum* Phillips & Keith, a fungus found growing on *Juniperus communis* in Scotland. Saccardo (*op*. *cit*.) was unaware that the name *Keithia* had already been validly applied to a genus of flowering plants in the Capparidaceae, and later to a genus of Labiatae. Korf (1962) has already discussed the nomenclator of *Didymascella*.

Keithia Sacc. was monographed by Durand (1913). He recognized three species, *K. tetraspora* (Phillips & Keith) Sacc., *K. thujina* Durand and *K. tsugae* (Farlow) Farlow in Durand, and considered the genus to belong in the Stictidaceae.

Kirschstein (1941) erected *Fabrella* for *Stictis tsugae* Farlow (1883). Korf (1962) was convinced that *F. tsugae* (Farlow) Kirschstein was closely related to *Rhabdocline*. Lanier et al. (1978) treated both *Fabrella* and *Didymascella* as members of the Hemiphacidieae in the Hemiphacidiaceae. We concur. However, we do not consider the Hemiphacidiaceae *auct.* to be a natural grouping.

5. *Laqueria* Fries.

Type species: *L. sphaeralis* (Fries) Fries.

Laqueria (Fries 1849) was assigned to the Ostropaceae *sensu* Rehm (Rehm 1896). An illustration and a short description of *L. sphaeralis* was provided. Dennis (1968, 1978) referred the genus to the Phacidiaceae, providing a description and an undiagnostic illustration of *L. sphaeralis*. According to Dennis (*op. cit.*) the ascal apices are non-amyloid. This alone may exclude *L. sphaeralis* from the Phacidiaceae *sensu* DiCosmo, Nag Raj & Kendrick. Sherwood (1977) excluded *L. sphaeralis* from the Ostropales and the Phacidiaceae. We fully agree. We have not seen any authentic material. Dennis (1978) and Sherwood (1977) pointed out that the species may be referable to the 'pyrenomycetes'.

6. *Lasiostictis* (Saccardo & Berlese) Saccardo.

For a detailed account of *Lasiostictis*, see *Naemacyclus* Fuckel.

7. *Lophophacidium* Lagerberg.

Type species: *L. hyperboreum* Lagerberg.

This taxon will be discussed in detail under the Phacidiaceae.

8. *Macroderma* Hoehnel.

Type species: *M. curtisii* (Berkeley & Ravenel) Hoehn.

Hoehnel (1917) introduced *Macroderma* for *Rhytisma curtisii* Berk. & Rav. The fungus was carefully studied by Luttrell (1946), who provided a detailed taxonomic history, and a well-documented account of the life history and ecology of the fungus. Luttrell considered *M. curtisii* not generically distinct from *Phacidium*. However, our studies of this species have revealed considerable justification for its segregation; so much so that we propose not merely its retention, but its transfer from the Phacidiaceae to the Rhytismataceae.

The Rhytismataceae is characterized by a carbonous, black, irregular stroma which may be immersed in the host tissues or may appear superficial. The ascoma may have one to several hymenial areas of true paraphyses and asci. The mature stroma ruptures the covering layer when the asci are mature. The asci are uniformly thin-walled and are often pierced apically by a delicate pore. The ascal apices never give a positive amyloid reaction (but consider *Odontotrema rhopalospermum*). Asci are 4-8-spored, ovoid to subcylindrical, 0-several-septate, and usually entirely enveloped in a gelatinous coat, or the extremities may bear gelatinous caps.

Macroderma curtisii and *Phacidium uleanum* Rehm (Rehm 1900) share the 'rhytismataceous' characteristics described above. Undoubtedly, M. curtisii and P. uleanum are closely related to each other and to Rhytisma Fr. However, no modern monographic treatment of Rhytisma has been published. In its absence we propose to accept Macroderma, with M. curtisii as its type species, and transfer P. uleanum to that genus.

Macroderma Hoehnel, Ber. Deutsch. Bot. Ges. 35: 422 (1917b).

Foliicolous. Ascomata at first immersed, subcuticular to subepidermal, ultimately raising the overlying fungus and host tissues into black swellings; covering fungal tissue composed of vinaceous outer pseudoparenchymatous cells forming a textura globulosa which becomes hyaline and prosenchymatous toward the interior, rupturing stellately to expose a dense, pale yellow hymenium of asci and paraphyses; subhymenium of textura angularis. Asci clavate, 8-spored, uniformly thick-walled, except for the thin-walled apex which becomes pierced by a pore at maturity and ruptures irregularly; apex non-amyloid (I^-). Ascospores uniseriate within the ascus, obovoid to ellipsoid, hyaline to pale yellow, smooth-walled.

KEY TO THE SPECIES OF MACRODERMA

Ascospores without or rarely with gelatinous sheaths, uniseriate,
obovoid to ellipsoid, hyaline to pale yellow, smooth-walled,
mean length/width ratio = 3.6:1.................... M. curtisii (a).
Ascospores with gelatinous sheaths, biseriate,
fusiform, straight or curved, hyaline,
mean length/width ratio = 5:1....................... M. uleanum (b).

a) Macroderma curtisii (Berk. & Rav.) Hoehn. Fig. 60.
Ber. Deutsch. Bot. Ges. 35: 422 (1917b).
≡ Rhytisma curtisii Berkeley & Ravenel, North American Fungi no. 780 (1859).
≡ Phacidium curtisii (Berk. & Rav.) Luttrell, Bull. Torrey Bot. Club 67: 701 (1940).

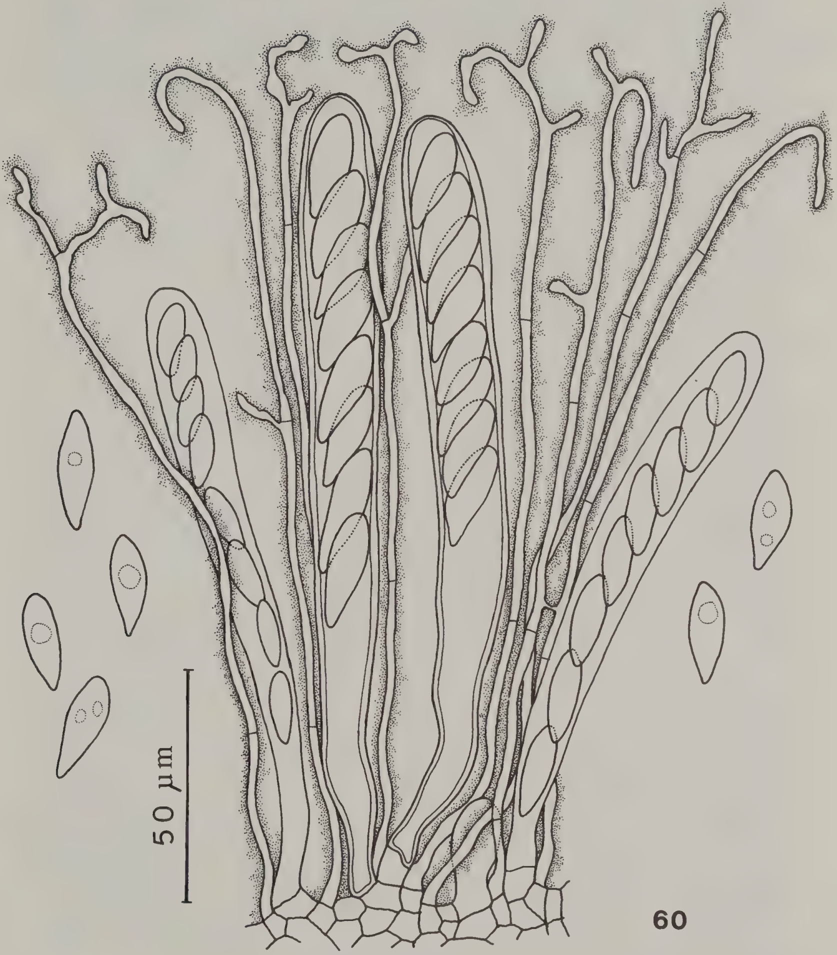
Foliicolous. Ascomata amphigenous, scattered to gregarious, often becoming confluent, at first immersed, subcuticular to subepidermal, ultimately raising the overlying fungus and host tissues into black, pulvinate or irregular swellings up to 4000 µm long and 2000 µm wide; the fungal covering layer rupturing stellately to expose the hymenium; overlying fungal tissue composed of vinaceous outer pseudoparenchymatous cells forming a textura globulosa up to 200 µm thick, becoming hyaline and prosenchymatous toward the interior. Hymenium usually plane, pale yellow, up to 200 µm thick, composed of asci and epithecium up to 10 µm thick; subhymenium up to 10 µm thick, composed of compacted hyphae forming a textura angularis. Asci clavate, 8-spored, uniformly thick-walled, except for the thin-walled, rounded apex which is non-amyloid (I^-), apex ultimately pierced by a delicate pore and rupturing irregularly, 112-170 X 10-15 ($\bar{x}$ = 140 X 11.5) µm. Ascospores uniseriate within the ascus, 20-25 X 5-7 ($\bar{x}$ = 22 X 6) µm, mean length/width ratio = 3.6:1. Paraphyses simple or branched, subcylindrical, septate, hyaline, smooth-walled, up to 200 µm long and 2-2.5 µm wide, frequently anastomosing and invested in mucilage.

Habitat: on leaves of Ilex opaca.

Known distribution: U.S.A. (Georgia, South Carolina).

Specimens examined: In FH, Authentic, Ravenel, Fungi Am. exs. no. 26; Ellis, North American Fungi no. 647, Ravenel, Aiken, South Carolina, U.S.A.

b) Macroderma uleanum (Rehm) DiCosmo, Nag Raj & Kendrick comb. nov.
≡ Phacidium uleanum Rehm, Hedwigia 39: 80 (1900).



60

Macroderma curtisii. 60. Asci, ascospores, and paraphyses: paraphyses invested in mucilage.

Foliicolous. Ascomata amphigenous, scattered to gregarious, initially immersed, subepidermal, raising the overlying host and fungal tissues into irregular swellings, 300-2000 µm diam. Ultimately splitting open irregularly or stellately to expose the hymenium. Reflexed lobes of fungal tissue heavily stromatic, up to 500 µm thick at the apex, composed of dark-vinaceous outer pseudoparenchymatous cells forming a *textura globulosa*, and pale pink *textura intricata* toward the interior. The hymenium proper is shallow-cupulate, pale yellow, mostly immersed, up to 150 µm thick, composed of asci and paraphyses; subhymenium up to 20 µm thick, composed of closely interwoven, septate hyphae. Asci club-shaped, 8-spored, uniformly thick-walled except for the thin-walled apex, 130-150 X 12-15 (x = 145 X 13.5) um, at maturity becoming pierced by a delicate, non-amyloid (I^-) pore. Ascospores biseriate, fusiform, straight or curved, hyaline, smooth-walled, 20-25 X 4 ($\bar{x}$ = 22.5 X 4) µm, mean length/width ratio= 5:1, invested in a gelatinous sheath which is drawn out above and below. Paraphyses simple or branched, flexuous, septate, hyaline, up to 150 µm long, 1.5-2 µm wide, invested in mucilage.

Habitat: leaves of *Ilex paraguensis*.

Known distribution: Brazil.

Specimens examined: In S, Holotype, E. Ule no. 574, Brazil; in FH in Patouillard herbarium (sub "*Phacidium* sur *Ilex theezans*..."), Brazil.

Both *M. curtisii* and *M. uleanum* (material in FH), exude a vinaceous dye when rehydrated in 2% aqueous KOH. The holotype material of *M. uleanum* from S, although identical in most characters to that from FH, did not yield this colour reaction, but in vertical section the host epidermal cells are often stained pink by the fungus tissues. The two species are similar in host preference and in morphology of ascomata and asci. The ascospores of *M. uleanum*, unlike those of *M. curtisii*, consistently bear gelatinous sheaths. DiCosmo (1979) pointed out that, in old collections of *Lasiostictis fimbriata*, gelatinous sheaths are especially difficult to see. Perhaps the gelatinous sheaths on ascospores of *M. curtisii* are more easily discernible when fresh material is examined. The salient features shared by *M. curtisii* and *M. uleanum* show that they are appropriately disposed in the Rhytismataceae.

9. *Micraspis* Darker. Figs. 61-67.

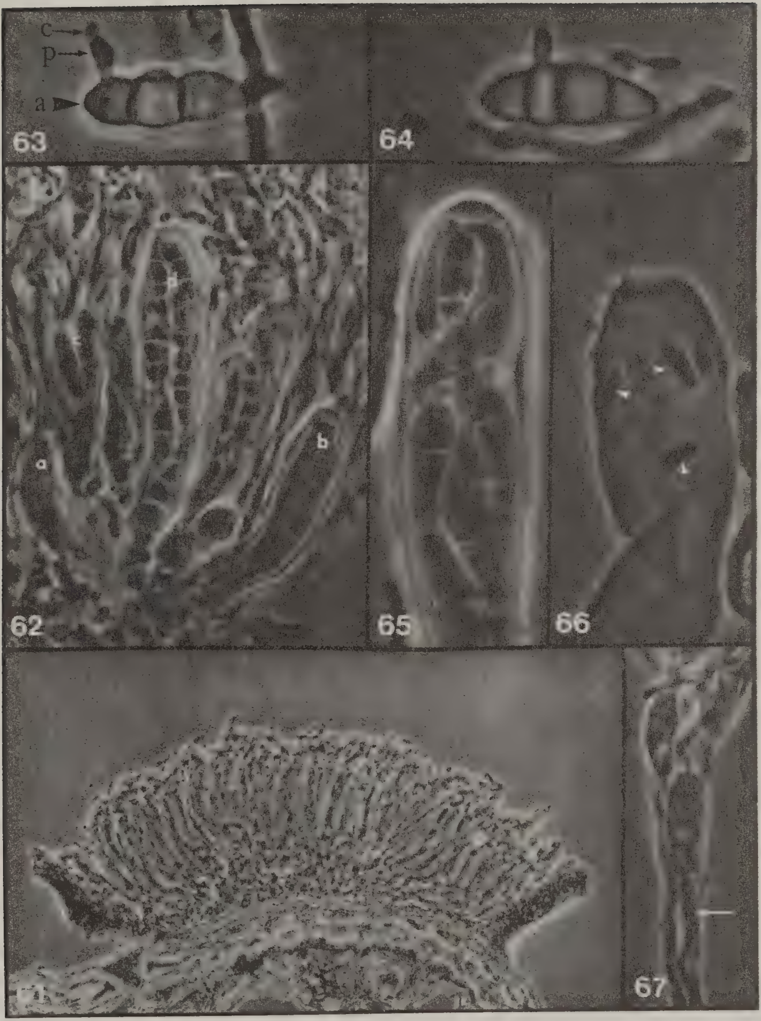
Type species: *M. acicola* Darker.
Anamorph: *Periperidium acicola* Darker.

Micraspis was erected for the single species, *M. acicola*, found growing on diseased leaves of *Picea mariana* (Mill.) B.S.P. by Darker (1963). The symptoms were similar to those caused by 'Phacidium snow-blights'. Darker (*op. cit.*) found that small trees bore diseased branches near the base, that would have been under the snow. The condition of the discoloured, diseased leaves clearly differed from that caused by *Lophophacidium hyperboreum*, which attacks *Picea* spp. in N. Europe and Eastern N. America.

Darker (1963) discussed the affinities of *Micraspis* with *Eupropolella* Hoehn., (Hoehnel 1917) and *Sphaeropezia* Sacc., (Saccardo 1884). Darker argued that the non-amyloid ascus apex and peculiar pycnidioid anamorph separated *Micraspis* from these genera. He also noted that *Micraspis* resembled *Phacidium* in certain characteristics. Darker assigned *Micraspis* to the Phacidiaceae, mainly on the strength of the "...dark excipulum..." presented by *M. acicola*. He also believed that *Micraspis* was a phragmosporous ally of *Schizothyrioma* Hoehn.

Dennis (1971) described *M. strobilina* Dennis on fallen cone scales of *Pinus sylvestris* L. in Britain.

Our observations of *M. acicola* (Holotype of teleomorph and anamorph DAOM 90961; 90962, 58535) are largely in agreement with those of Darker.



Micraspis acicola. 61. Vertical section of ascoma. x 190. 62. Detail of hymenium showing ascus development, a,b,c,d,. x 770. 63. Mature ascospore (a), and developing microconidium (c), emerging from a phialide (p). x 1280. 64. Mature ascospore bearing a phialide. x 1280. 65. Ascus with thickened apex and ascospores. x 1280. 66. Dehiscent ascus containing microconidia. x 1280. 67. Ascospore with germ tube (arrow) still contained in an ascus.

However, we have found that ascospores (Fig. 67) often germinated in the ascus. Of even greater significance is the discovery that individual cells of the ascospores often produce bacilliform, hyaline microconidia from subcylindrical to ampulliform phialides (Figs. 63, 64). Several dehiscent asci containing such propagules were found (Fig. 66).

Nag Raj & DiCosmo (1980) and Sutton (1980) provided good illustrations of the *Periperidium acicola* anamorph of *M. acicola*. Conidiogenesis is blastic-phialidic.

Darker's assignment of *Micraspis* to the Phacidiaceae is untenable. The anatomy of the fungal covering layer of both teleomorph (Fig. 61) and anamorph (Fig. 69) is not characteristic of the Phacidiaceae. The thickened, non-amyloid ascal apex (Fig. 65), and the phragmospores which produce blastic-phialidic microconidia, are completely atypical of the Phacidiaceae *sensu* DiCosmo, Nag Raj & Kendrick. The asci and ascospores of *M. acicola* are more reminiscent of *Claussenomyces* Kirschst. (Korf 1973; Ouellette & Korf 1979), and *Tympanis* Tode:Fr. (Ouellette & Pirozynski 1974). As in many ascomycetes, the asci of *M. acicola* are borne in succession (Fig. 62a,b,c,d). The patterns of ascospore germination and microconidia production found in *M. acicola* are reminiscent of ascospore ontogeny in *Tympanis confusa* Nyl. (Ouellette & Pirozynski 1974).

The anamorph, *Periperidium acicola*, is illustrated from the type collection (DAOM 90961) in Fig. 68 A-C. The pycnidioid conidiomata are amphigenous, scattered, subcuticular, elliptical to irregular in outline, pulvinate, unilocular, dark brown to black, with a wall of *textura epidermoidea*. In surface view (Fig. 68 B) the wall is composed of septate, brown, thick-walled, irregular hyphae that become agglutinated to form a compact integument. To Darker's (1963) observations should be added that the conidiophores arise all around the locule, are simple or branched, septate, hyaline, smooth-walled and often reduced to simple conidiogenous cells. Darker did not record that conidiogenesis was phialidic (Fig. 68 C).

Although the teleomorphs of *Micraspis*, *Claussenomyces* and *Tympanis*, share some similarities (even though the ascoma of *M. acicola* is much reduced), their respective anamorphs are very different. The *Periperidium* anamorph of *Micraspis acicola* does not resemble either the *Dendrostilbella prasinula* Hoehn. anamorph of *Claussenomyces prasinulus* (Karst.) Korf & Abawi, or the *Sirodothis* anamorph of *Tympanis confusa*. However, on the basis of asci that develop in succession, and ascospore morphology, coupled with blastic-phialidic microconidia produced directly from phialides on the ascospores, we suggest retention of *Micraspis* in the Helotiales: Leotiaceae, Tympaneae (Korf 1973).

10. *Melittosporium* Corda.

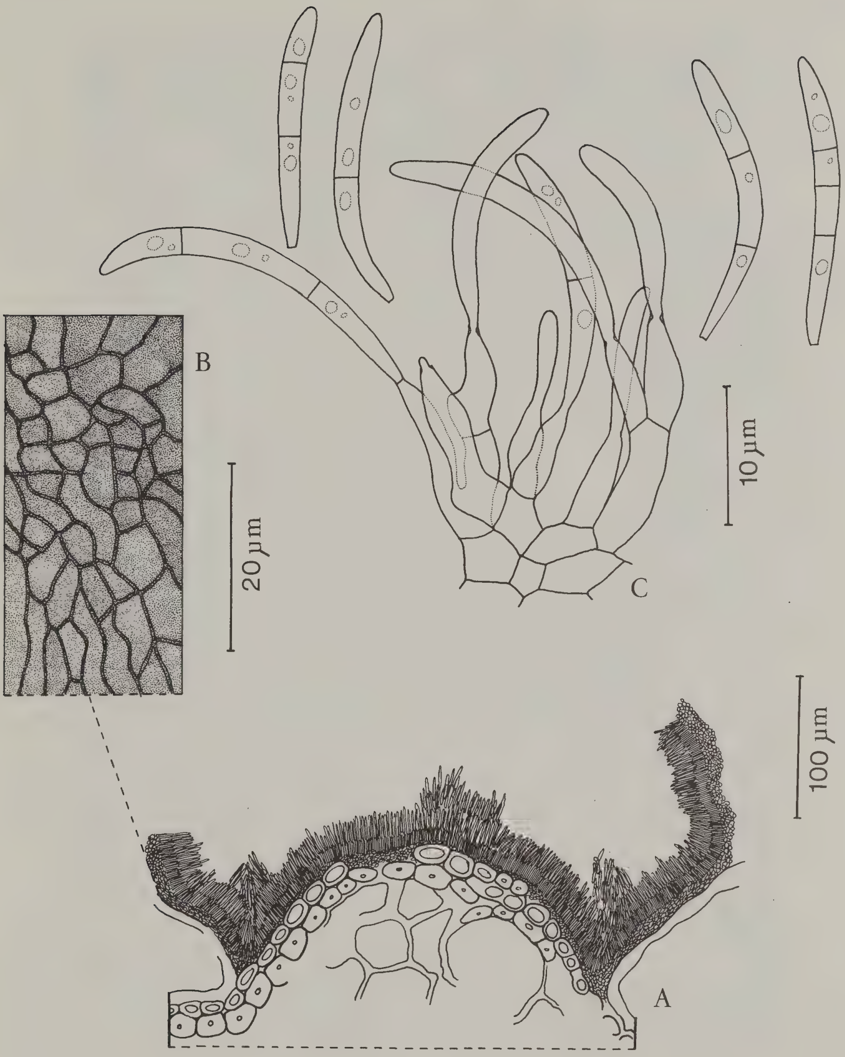
Type species: *M. versicolor* (Fr.) Corda.
Anamorph: unknown.

Sherwood (1977) provided an illustrated account of *Melittosporium*. She found that *M. versicolor* produced bitunicate asci with dark brown dictyospores and apically anastomosing pseudoparaphyses that form an epithecium in a hysteriform ascoma. The above characteristics clearly exclude *M. versicolor* from the Phacidiaceae *sensu* DiCosmo, Nag Raj & Kendrick, and suggest affinity to the Hysteriales (*fide* Sherwood 1977).

Lanier et al. (1978) considered that *M. versicolor* was related to *Cryptodiscus*, which they placed in the Peziculaceae. This is untenable if *M. versicolor* does indeed have bitunicate asci, as Sherwood contends. We have not studied any authentic material.

11. *Myxophacidiella* Hoehn.

12. *Myxophacidium* Hoehn.


B
20 µm
C
10 µm
100 µm
A

68

Periperidium acicola anam. of Micraspis acicola. 68. A. V.S. conidioma. B. Detail of wall. C. Phialides and conidia.

Both *Myxophacidiella* and *Myxophacidium* were introduced by Hoehnel (1917c) as segregates of *Pseudophacidium* Karsten. A discussion of these genera will be found under *Pseudophacidium*.

13. *Naemacyclus* Fuckel.
= *Lasiostictis* (Saccardo & Berlese) Saccardo.

Type species: *N. fimbriatus* (Schw.) DiCosmo, Peredo & Minter.
Anamorph: *Eriosporopsis albida* Petrak.

Fuckel (1873) introduced *Naemacyclus* for *N. pinastri* (≡ *Propolis pinastri* DeLacr. in Desm., Pl. Crypt. France Exs. 2: 791 (1861)) found on leaves of *Pinus maritima* in Austria. Saccardo (1884) suggested that *N. pinastri* was the same species as *N. niveus* (Pers.:Fr.) Fuckel:Sacc. (ut *N. niveus* (Pers.) Fuckel, (Saccardo 1889)). Rehm (1896) provided an expanded synonymy of *N. niveus*.

Saccardo (1889) erected *Lasiostictis* for *L. conigena* (Sacc. & Berl.) Sacc., and raised the subgeneric taxon *Stictis* (*Lasiostictis*) *conigena* Sacc. & Berlese (Saccardo & Berlese 1885) to generic rank. Rehm (1896) recognized that *L. conigena* was identical with *Stictis fimbriata* Schweinitz (Schweinitz 1834). Petrak (1947a) studied *Lasiostictis* and *Naemacyclus*, and found considerable similarity between *L. fimbriata* and *N. niveus*. He noted that the asci and ascospores of these species were similar, and suggested that *L. fimbriata* was a growth form of *N. niveus*. That same year, Petrak (1947b) introduced *Eriosporopsis* Petrak for *E. albida* Petr., the anamorph of *L. fimbriata*. Maire (1930) noted the strong similarity between *L. fimbriata* and *Stictis maritima*, and suggested that the two were related.

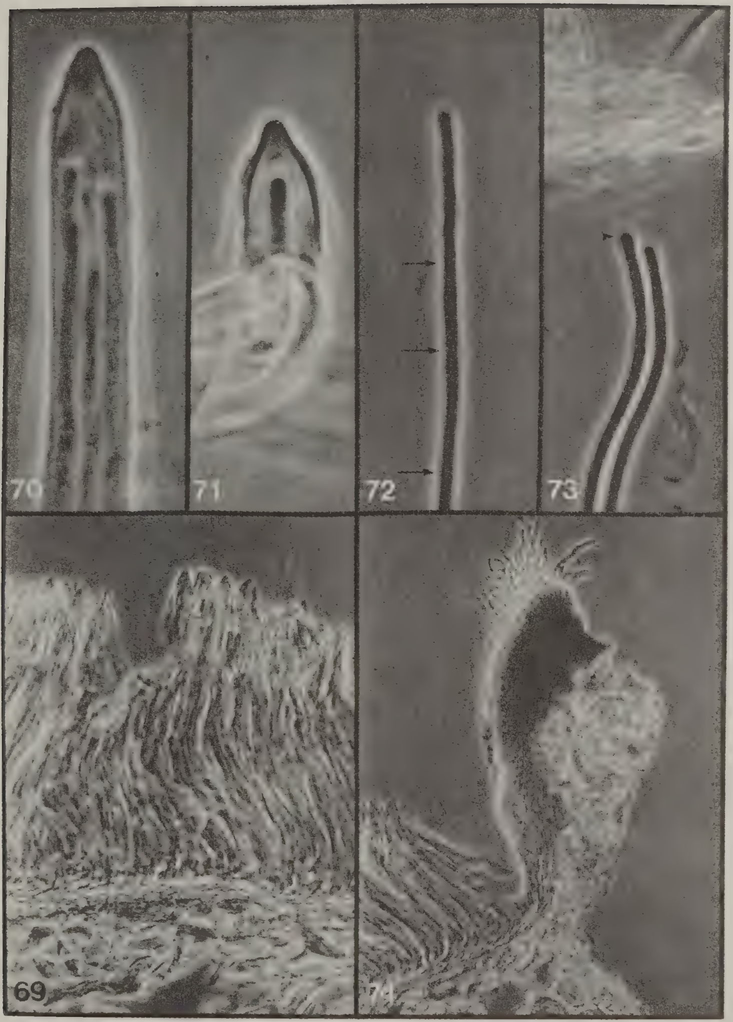
Mueller & Huetter (1962) redescribed *Stictis maritima* Rolland (Rolland 1898), and transferred it to *Coccomyces*.

Korf (1962) pointed out that all authors subsequent to Fuckel had based *Naemacyclus* on *Stictis nivea* Pers., later transferred to *Naemacyclus* by Saccardo (1884). Korf noted that *Naemacyclus* was monotypic at its inception and that species added to the genus later did not really belong in it.

Sherwood (1974) provided a well-documented account of the nomenclature and history of *L. fimbriata*. She decided that Petrak's (1947a) reasons for considering *L. fimbriata* and *N. niveus* conspecific were insufficient, so she referred *L. fimbriata* to the Phacidiaceae *sensu* Terrier, and retained *Naemacyclus niveus*.

We have found several anomalies in the present disposition of *L. fimbriata*. Most importantly, *N. pinastri* has not been interpreted in accordance with its type. Observations from both freshly collected and dried herbarium specimens indicate that *Naemacyclus* and *Lasiostictis* represent the same taxon, and cannot be retained in the Phacidiaceae *sensu* DiCosmo, Nag Raj & Kendrick, nor in the Phacidiaceae *sensu* Terrier. We echo Korf (1962) in suggesting that *Naemacyclus* is monotypic, based on *N. pinastri*, and that all other species now disposed in *Naemacyclus* are not congeneric with it. A complete study of these fungi was not intended in this report. However, a revision of *Naemacyclus* Fuckel is provided, and this genus is redisposed in the Rhytismataceae.

Naemacyclus fimbriatus (Schw.) DiCosmo, Peredo & Minter Figs. 69-74.
≡ *Stictis fimbriata* Schw., Syn. Fung. Amer. bor. 179 (1834).
≡ *Lasiostictis fimbriata* (Schw.) Baeumler, Ann. K. K. naturh. Hofmus. Wien 18 (1901).
= *Propolis pinastri* DeLacroix, in Desm., Plant. Crypt. France Exs. 2: 791 (1861).
≡ *N. pinastri* (DeLac. in Desm.) Fuckel, Jarhb. Nassauischen



Naemacyclus fimbriatus 69. Detail of hymenium and subhymenium (V.S.). x 310. 70. Apical region of ascus. x 1280. 71. Ascal apex. x 1280. 72. Portion of mature ascospore, arrows indicate septa. x 1280. 73. Two mature ascospores, arrow-head indicates mucilaginous coat. x 770. 74. V.S. of ascoma showing covering tissue and margin. x 190.

vereins Naturk. 27-28; 49 (1873).
= *Stictis* (*Lasiostictis*) *conigena* Saccardo & Berlese, Atti Reale Ist. Veneto Sci., lett., Arti 6839: 734 (1885).
≡ *Lasiostictis* *conigena* (Sacc. & Berl.) Sacc., Syll. Fung. 8. 696 (1889).
= *Stictis* *maritima* Rolland, Bull. Soc. Myc. France 14: 84 (1898).
≡ *Coccomyces* *maritimus* (Rolland) Mueller & Huetter, Rev. mycol. 27: 71 (1962), *teste* Sherwood (1974).

Ascomata on leaves and female cone scales, occurring on all surfaces, scattered to gregarious, immersed, erumpent, circular to subcircular in outline, up to 450 µm diam., raising the overlying host tissue into irregular swellings, then rupturing the overlying fungal tissue; covering fungal tissue of dark brown to black outer pseudoparenchymatous cells, forming a *textura globulosa* which becomes less pigmented toward the interior; innermost layer composed of numerous periphysoids, simple or branched, flexuous, hyaline, up to 45 X 2.5 µm, with gelatinizing outer walls, often with minute incrustations and rounded apices. Hymenium up to 100 µm thick, pale yellow; subhymenium of crowded, hyaline, pseudoparenchymatous cells in a *textura angularis* up to 17 µm thick; basal stroma of subhyaline to pale yellow *textura globulosa*. Asci club-shaped, 8-spored, tapering toward the papillate apex, which is thin-walled, non-amyloid (I^-) and smooth-walled, 87-100 X 9-10 ($\bar{x}$ = 94 X 9.5) µm. Ascospores phragmo-scolecosporous, club-shaped, tapered below, rounded above, usually 7-septate, hyaline, smooth-walled, 75-90 X 2-2.5 ($\bar{x}$ = 83 X 2) µm, mean length/width ratio = 42:1, and invested in a gelatinous sheath. Paraphyses abundant, sparsely septate, up to 100 X 1-1.5 µm, hyaline, smooth-walled and invested in mucilage.

Habitat: on leaves of *Pinus maritima* and cone scales of *P. nigra* and *P. sylvestris*.

Known distribution: Europe; North America.

Specimens examined: In FH, Type, *Propolis pinastri* in Desmazières Pl. Crypt. France 2: 791 (1861), on *Pinus nigra* leaves; Petrak, Myc. gen. 678, Petrak, Niederdonau, Weissenbach, Triesting, Schrommenau, 1941-III, on *P. nigra* leaves; Petrak Myc. gen. 252, Petrak, Tirol, Innsbruck, 1940-VII, on female cone scales of *P. sylvestris*; Sydow, Myc. germanica 706, P. Sydow, Brandenburg, 1908-VII-02, on female cone scales of *P. sylvestris*; Ellis N. American Fungi 72, on *P.* (?) *sylvestris* cone scales; Rabenhorst-Winter Fungi Eur. 4070, W. Krieger, Saxonia, 1893-V, on female cones of *P. sylvestris*; Rehm ascomyceten 1094 a & b, Starback, Sandham, Sweden, 1892, on female cones of *P. sylvestris*; Vestergren Micromycetes Rariores Selecti 115, Vestergren, Sweden, 1897, on female cone scales of *P. resinosa*; in BPI *sub* *Phacidium pustulatum* Ellis *nom. ined.*, Newfield New Jersey, U.S.A. 1880-III.

Sherwood (1974) correctly pointed out that the hyphae of the covering layer of *L. fimbriata* have a vertical orientation (Fig. 74) when covering the hymenium. The gelatinous sheaths (Figs. 65, 66) escaped detection, apparently because in old collections these sheaths are especially difficult to see. In addition, although Sherwood (1974) stated that the ascus apex (Fig. 71) of *L. fimbriata* "blues faintly in iodine," we were unable to confirm this observation. Asci from ascomata rehydrated in distilled water alone or in 2% aqueous KOH, and then mounted in Melzer's reagent, showed no trace of the amyloid reaction. If these attributes are considered *in toto*, then *L. fimbriata* is referrable to the Rhytismataceae (Korf 1973) rather than the Phacidiaceae. DiCosmo (1979) has already redisposed *Lasiostictis* in the Rhytismataceae.

The fungus that all recent authors have called *N. niveus* is quite different from *N. fimbriatus*. *N. niveus* produces ascomata on yellow-brown, discoloured leaves in late summer and autumn. The mature ascomata are irregularly ellipsoid, but always dehiscent by an irregular longitudinal slit that ruptures the covering layer. Such a dehiscence mechanism is apparently never found in *N. pinastri*. Millar & Minter (1980) and Minter & Millar (1980b) provided illustrations and descriptions for *N. minor* Butin and *N. niveus*. These authors did not record several key characteristics found in *N. minor*, apparently the most common species. No mention was made of the margin (Figs. 76, 81, arrows). The subcylindrical to club-shaped asci have a thin-walled, non-amyloid (I$^-$) apex that ruptures to release the ascospores. Most significantly, we found that the extremities of the curved, sub-cylindrical, 2-septate ascospores were surmounted by gelatinous caps (Figs. 78, 79, arrowheads). We also noted that the septate paraphyses which frequently anastomosed with their neighbours were sometimes slightly swollen at the apices and were invested in mucilage (Fig. 77, arrows indicate septa).

DiCosmo, Peredo & Minter (1983) found it necessary to introduce the genus *Cyclaneusma* to accommodate *N. minor* and *N. niveus*.

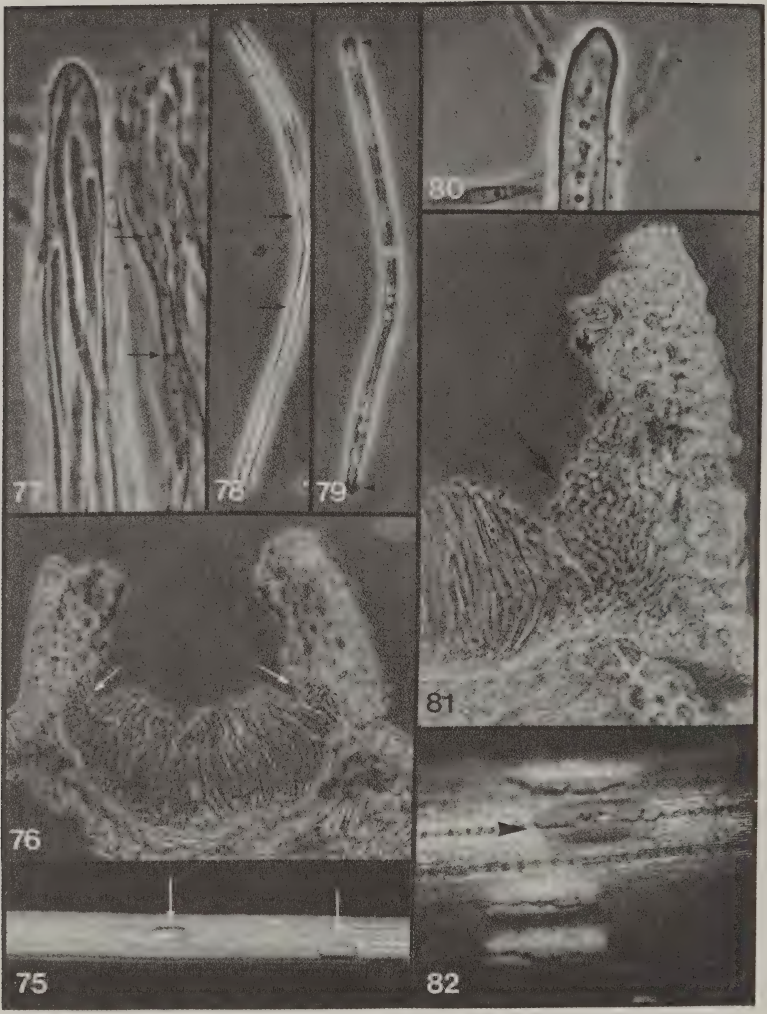
No single author has yet elucidated the opening and closing mechanism responsible for the dehiscence of ascomata in *N. minor*. Darker (1932) commented that the covering layer opens widely in *N. niveus*, and the epidermal tissue remains hinged along the sides of the ascomata. However, the opening mechanism of *N. minor* is more sophisticated than a simple rupturing of epidermal and hypodermal tissues of the host. The initial longitudinal rupture occurs along the line of least resistance (Fig. 82, arrowhead) and may be caused by imbibition of water by the internal fungal tissue (here called the margin) that flanks the hymenium. During a dry period, the individual cells of the margin dehydrate and shrink. This rapid loss of volume results in the "pulling in and closing" of the covering layer. When rehydrated, the cells of the margin, which have gelatinizing outer walls, and are invested in mucilage, swell rapidly. It is this increase in volume that forces the covering layer open.

Since *C. minus* is a common pathogen that causes considerable damage to commercial pine plantations in Eastern N. America, it is redescribed here. We have not studied authentic material of *N. niveus*.

Cyclaneusma minus (Butin) DiCosmo, Peredo & Minter Figs. 75-82.
Eur. J. For. Path. 13: 208 (1983).
≡ *N. minor* Butin, Eur. J. For. Path. 3: 160 (1975).

Foliicolous. Ascomata on browned leaves, amphigenous, scattered to gregarious, often confluent, marked by pale yellow-brown, irregular bands, immersed, subhypodermal, raising the overlying host tissue into irregularly elliptical swellings, 400-1000 X 300-500 µm, which rupture longitudinally by a single median slit, forming two flaps that ultimately open widely to expose a dense hymenium. Hymenium cream to pale yellow, up to 112 µm thick; composed of asci and paraphyses, subhymenium of densely packed, septate, hyaline, hyphae forming a *textura angularis* up to 20 µm thick which differentiates into a *textura oblita* toward the flanks and forms an immersed margin; margin intrahypodermal to subhypodermal, up to 50 µm thick, composed of cylindrical to subglobose cells up to 5 µm diam., with gelatinizing outer walls, and immersed in a gel. Asci 8-spored, subcylindrical to club-shaped, tapered toward the thin-walled apex, (100-) 105-110 (-112) X 10-12.5 ($\bar{x}$ = 106 X 11.5) µm, immersed in copious mucilage. Ascospores scoleco-phragmosporous, guttulate, 2-septate toward the centre, subcylindrical, tapered slightly toward the rounded ends, hyaline, smooth-walled, (50-) 60-100 (-105) X (2-) 2.5 (-3) ($\bar{x}$ = 80 X 2.5) µm, mean length/width ratio = 32:1, with a gelatinous cap at each end. Paraphyses subcylindrical, simple or branched, apices rounded and slightly swollen, forming a shallow epithecium, septate, hyaline, smooth-walled, up to 115 X 2 µm, frequently anastomosing and invested in copious mucilage.

Habitat: on leaves of *Pinus caribaea*, *P. contorta*, *P. flexilis* *P. jeffreyi*, *P. montana*, *P. mugo*, *P. nigra* var. *austriaca*, *P. patula*, *P. ponderosa*, *P. radiata*, *P. sabiniana*,



Cyclaneusma minus from material in WAT. 75. Habit, arrows indicate two ascomata. x 6.5. 76. V.S. ascoma, arrows indicate the immersed margin. x 125. 77. Detail of ascus and septate paraphysis (arrows). x 1280. 78, 79. Two ascospores, arrows denote septa; arrow-heads indicate mucilaginous caps. x 1280. 80. Part of ascus showing thin-walled apex. x 1280. 81. Detail of ascoma, arrow denotes margin. x 190. 82. Habit, arrow-head indicates line of dehiscence. x 20.

P. strobus, *P. sylvestris*, *P. uncinata* and *P. wallichiana*.

Known distribution: Kenya; Malawi; Morocco; S. Africa; Tanzania; Pakistan; Australia; Austria; Belgium; Canada (Ontario); Chile; Colombia; Czechoslovakia; Denmark; Ecuador; France; Germany; Great Britain; Italy; Spain; Switzerland; New Zealand; Uruguay; U.S.A. (California, Michigan, Pennsylvania).

Specimens examined: In FH, Saccardo Myc. Ital. 681, A. Fiori, Italy, 1901-IV; in WAT, ex herb. F. DiCosmo, B. Kendrick, Waterloo, Ontario, Canada, 1980-VIII.

14. *Nannfeldtia* Petrak.

Type species: *N. atra* Petr.
Anamorph: unknown.

Petrak (1947c) introduced *Nannfeldtia* for *N. atra*, a fungus found on leaves of *Carex firma*, and assigned it to the Phacidiaceae. The fungus was described in detail, but not illustrated.

Korf (1973) accepted *N. atra* as a member of the Phacidiaceae, but Nannfeldt (1976) concluded that the habit of *N. atra* provided an example of convergent evolution leading to "hemisphaeroid" ascomata. He found that the anatomy of the fungal integument was atypical of the Phacidiaceae, but was similar to that seen in the Microthyriaceae. We agree with Nannfeldt. The immature asci are apically thickened. Ultimately, the apex becomes flattened with an amyloid (I^+) dehiscence ring. We concur with Nannfeldt's (1976) exclusion of *N. atra* from the Phacidiaceae. Further, we believe that *N. atra* is closely related to *Phacidina gracilis* (Niessl) Hoehn. (Figs. 90-96), which we also exclude from the Phacidiaceae.

Holm & Holm (1977b) revised the Leptopeltidaceae. Their concept of that family could accept both *Nannfeldtia* and *Phacidina*, except for the amyloid (I^+) dehiscence rings of *N. atra* and *P. gracilis*. Despite this single anomaly, we tentatively suggest that both *N. atra* and *P. gracilis* are better disposed in the Leptopeltidaceae.

15. *Neophacidium* Petrak.

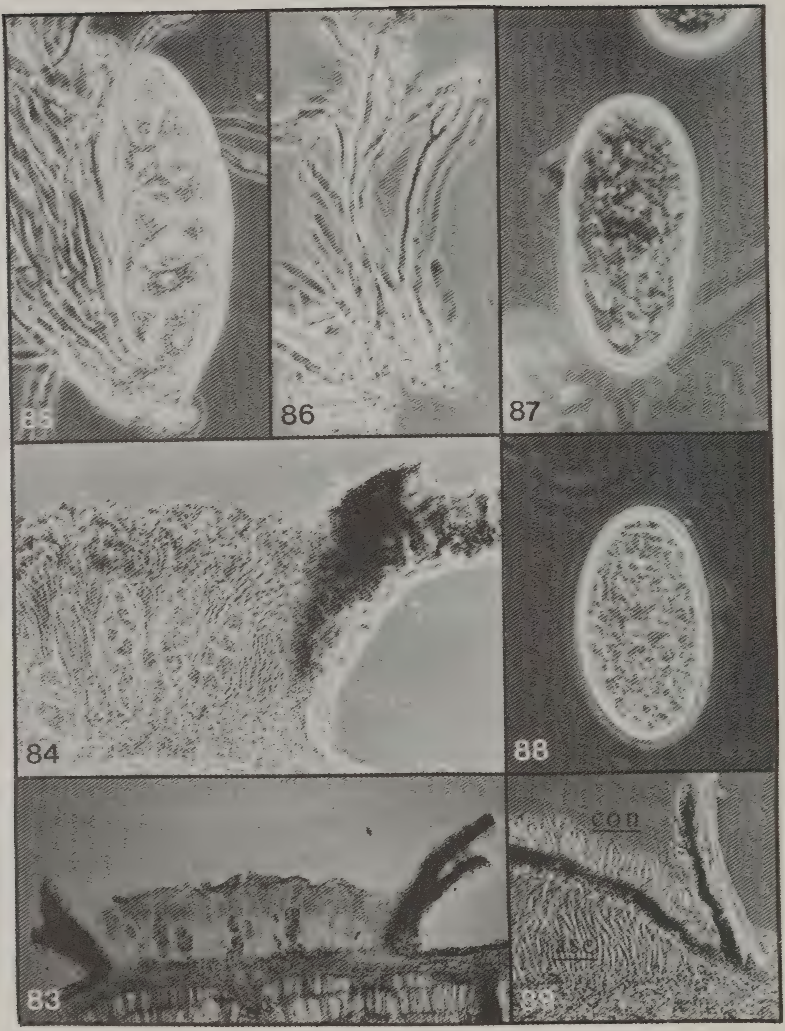
Type species: *N. macrocarpum* (Pat.) Petr.
Anamorph: *Melasmia vel aff.*

Patouillard (1892) described *Phacidium macrocarpum* Pat. for a fungus on leaves of *Gynoxys laurifolia* in Ecuador. Petrak (1950) found that the paraphyses of *P. macrocarpum* were immersed in a gel and formed an epithecium. This feature led him to erect *Neophacidium*.

Through the courtesy of Dr. D. H. Pfister (FH) the holotype specimen of *P. macrocarpum* has been examined.

Neophacidium macrocarpum (Pat.) Petr. Figs. 83-89.
Sydowia 4: 333 (1950).
≡ *Phacidium macrocarpum* Patouillard, Bull. Soc. Myc. Fr. 8: 126 (1892).

Caulicolous. Ascomata strictly epiphyllous, scattered to gregarious, initially immersed, intraepidermal, raising the overlying host and dark brown to black fungal tissues into irregular swellings, 500-1500 µm diam., ultimately splitting open irregularly to expose the hymenium. Reflexed teeth of fungal tissue composed of brown outer pseudoparenchymatous cells forming a *textura globulosa*. Hymenium dark smoky-grey, composed of asci and paraphyses; subhymenium composed of hyaline *textura globulosa* up to 40 µm thick. Asci clavate, with a short basal stipe, 8-spored, 100-160 X 45-55 ($\bar{x}$ = 125 x 48) µm, with walls up to 2 µm thick, except for the thin-walled, non-amyloid (I^-) apex, and dehiscent by irregular rupture. Ascospores biseriate



Neophacidium macrocarpum. 83. V. S. ascoma. x 50. 84. Detail of ascoma, showing fungal roof, asci and pseudo-epithecium. x 75. 85. Ascus, showing arrangement of ascospores. x 310. 86. Branched paraphyses. x 310. 87, 88. Ascospores. x 770. 89. Detail of developing ascoma (asc), and overlying conidioma and conidiophores (con) of presumed anamorph. x 130.

within the ascus, oblong-ellipsoid to subglobose, deformed by mutual pressure within the ascus, pale yellow, smooth-walled, usually with a centrally located guttule, 30-41 X 20-25 ($\bar{x}$ = 36 X 22) µm, mean length/width ratio = 1.6:1. Paraphyses abundant, simple or branched, flexuous, hyaline, often with minute, irregularly disposed encrustations, septate, up to 250 X 2-2.5 µm, with rounded apices immersed in a granular, pale brown, amorphous matrix forming a pseudoepithecium.

Habitat: on leaves of *Gynoxys hallii*, *G. laurifolia*.

Known distribution: Ecuador; Venezuela (*fide* Dennis 1970).

Specimens examined: in FH, Holotype Patouillard herbarium, Lagerheim, Quebrada de la Carolina (Pichincha), Ecuador, 1891-VII; also in FH, Lagerheim, Pichincha, Ecuador, 1890; in S, H. Sydow, Pichincha, Quito, Ecuador, 1937-IX-28.

Sydow (1939) gave a good description of *P. macrocarpum*, and maintained that its anamorph could be accommodated in *Melasmia* Lev. Petrak (1950) introduced *Neophacidium* Petrak for *P. macrocarpum*, and he too found an anamorph referable to *Melasmia*. We often found that the ascomata developed beneath conidiomata of the presumed anamorph (Fig. 89). This presumed anamorph may in fact belong in *Melasmia*, but the material we studied was too poor to allow adequate characterization.

Korf (1973) placed *Neophacidium* in the Phacidiaceae. More recently, Lanier et al. (1978) found that *N. macrocarpum* differed from *Phacidium* spp. in possessing an "epithecium". Pirozynski & Weresub (1979) reiterated this view. We have found that *Neophacidium* is distinct from *Phacidium* in more respects than the presence of a pseudoepithecium. *N. macrocarpum* lacks an iodine-positive dehiscence mechanism in the ascal apices, and the anatomy of its covering layer is atypical of *Phacidium* or any other member of the Phacidiaceae *sensu* DiCosmo, Nag Raj & Kendrick. The anamorph-genus *Melasmia* has been associated with members of the Rhytismataceae (Hennebert & Bellemere 1979; Kendrick & DiCosmo 1979). This may mean that *N. macrocarpum* should be referred to the Rhytismataceae.

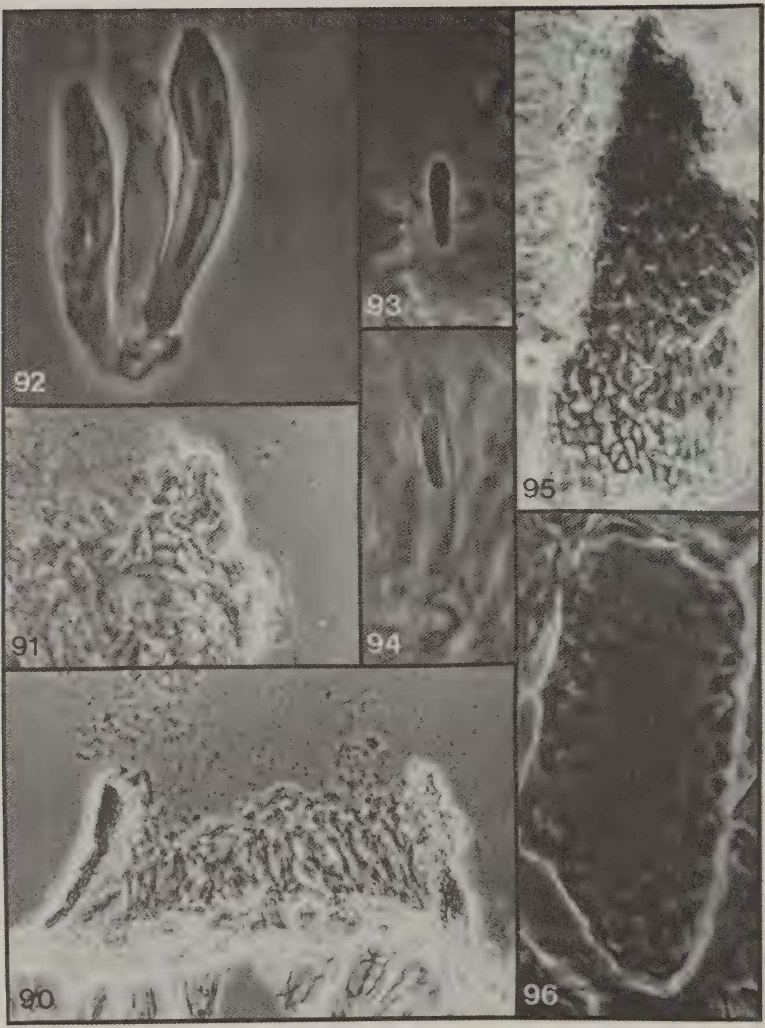
16. *Phacidina* Hoehn.

Type species: *P. gracilis* (Niessl) Hoehn.
Anamorph: unknown.

Neissl (1882) introduced *Phacidium gracile* Niessl for a minute ascomycete on *Lycopodium* sp. Hoehnel (1917a) made this fungus the type of a new generic name, *Phacidina* Hoehn., which he referred to the Leptopeltidaceae *sensu* Hoehnel, (*ut* "Leptopeltideen v. H.," Hoehnel, 1917b). Theissen (1918) found *P. gracilis* reminiscent of the Microthyriaceae. Arx & Mueller (1954) believed that *P. gracilis* could be better maintained in the Phacidiaceae, a view subsequently adopted by Korf (1973). No recent author has examined this fungus in sufficient detail to permit its unequivocal disposition in any family.

The herbarium material of *P. gracilis* we examined was in very poor condition, and resolution of morphological characteristics was difficult. However, an ample, fresh collection of what we believe is the same fungus, from the Pinery Provincial Park, Ontario, Canada, has enabled us to dispose the genus *Phacidina* satisfactorily.

Phacidina gracilis (Neissl) Hoehnel Figs. 90-96.
Annls. Mycol. 15: 324 (1917).
≡ *Phacidium gracile* Niessl, Osterr. Bot. Zeitschr. 32: 357 (1882).
= *Myiocopron lycopodii* Rostrup, Beih. Bot. Centralbl. 53: 3 (1893), *teste* Thiessen, Annls. Mycol. 16: 175-188 (1918).



Phacidina gracilis ex material from herb. WAT. 90. V.S. of ascoma. x 190. 91. Detail of covering layer. x 1280. 92. Asci and ascospores. x 1280. 93, 94. Mature ascospores. x 1280. 95. Detail of surface of ascoma. x 1280. 96. Host cell with intracellular mycelium. x 1280.

Foliicolous. Ascomata amphigenous, scattered to gregarious, sometimes becoming confluent, subcircular in outline, brown, 90-200 µm diam., when confluent, up to 400 µm long, initially immersed, subcuticular, raising the cuticle into swellings, then lacerating the overlying fungal tissue and host cuticle stellately into 4-8 irregular teeth, which reflex to expose the circular, hyaline hymenium. Overlying fungal tissue of brown, outer pseudoparenchymatous cells forms a *textura epidermoidea* which is hyaline toward the hymenium, up to 15 µm thick, with the inner hyaline cells enveloped in mucilage hymenium flat, up to 30 µm thick; subhymenium hyaline, of *textura angularis* 4-5 µm thick. Asci 8-spored, club-shaped, tapered toward the flat apex which has a delicate, amyloid (I^+) dehiscence ring; 25-30 X 5-6 ($\bar{x}$ = 27 X 5.5) µm. Ascospores biseriate, club-shaped, straight or curved, ends rounded, unicellular, guttulate, hyaline, smooth-walled, 6-8 X 1.5 (-2) ($\bar{x}$ = 6.5 X 1.5) µm, mean length/width ratio = 4.3:1. Paraphyses sparse, filiform, subcylindrical, simple or rarely branched, hyaline, smooth-walled, up to 30 µm long and 1.5-2.5 µm wide, invested in mucilage.

Habitat: *Lycopodium complanatum*, *L. tristachyum*, *Lycopodium* sp.

Known distribution: Canada (Ontario); Europe.

Specimens examined: In FH, Rabenhorst-Winter, Fungi Europaei 2959, W. Voss, Laibach, Carbiolia, 1883-V; as *Myiocopron lycopodii* (part of holotype); in WAT ex herb. DiCosmo, F. DiCosmo & K. Bergman, Pinery Prov. Pk., Lambton Co., Ontario, Canada, 1979-IX-23.

The subcuticular fungal covering layer of *textura epidermoidea* is not characteristic of the Phacidiaceae. From the description and illustrations presented here, *P. gracilis* may occupy an isolated or peripheral position (with *Nannfeldtia atra*) in the Leptopeltidaceae. Holm & Holm (1977) maintained the Leptopeltidaceae for fungi with scutelliform ascomata of radially oriented files of cells, opening by irregular or hysteriform splits in the cover. They found the ascus structure to be intermediate in organization between unitunicate and bitunicate. Holm and Holm found evidence suggestive of a rudimentary, non-amyloid (I^-) apical dehiscence mechanism. The thin-walled asci of *P. gracilis* have an amyloid (I^+) apical dehiscence ring, and do not appear closely related to those of the Leptopeltidaceae. However, the ascomata of *P. gracilis* are reminiscent of that family. *Phacidina* may be isolated within the Leptopeltidaceae *sensu* Holm & Holm, but is better retained in that family than in the Phacidiaceae. *Nannfeldtia atra* was tentatively referred to the Leptopeltidaceae for similar reasons.

17. *Phacidiostroma* Hoehn.

18. *Phacidium* Fr.

These two genera form part of the main theme of this work, and we discuss them in detail in the section dealing with the Phacidiaceae *sensu stricto*.

19. *Potebniamyces* Smerlis.

≡ *Phacidiella* Potebnia (*non Phacidiella* Karsten).

Type species: *Potebniamyces pyri* (Berk. & Br.) Dennis.
Anamorph: *Phacidiopycnis piri* (Fuckel) Weindlmayr.

Potebnia (1912) introduced *Phacidiella* Poteb. for the single species *Phacidiella discolor* (Mouton & Sacc.) Potebnia (≡ *Phacidium discolor* Mouton & Sacc., Mouton & Saccardo 1889), found on branches of *Pyrus* sp. in Belgium. *Phacidiella* was referred to the Phacidiaceae (Potebnia 1912). Hoehnel (1917c) amended the genus, transferred it to the Stictideae, and provided an expanded synonymy. Clements & Shear (1931) interpreted

Phacidiella in the original sense of Potebnia, and maintained it in the Phacidiaceae. Nannfeldt (1932) demurred, transferring *Phacidiella* to the Myriangiaceae. Arx & Mueller (1954) considered that *Phacidiella* was best maintained in the Cryptomycetaceae.

Hahn (1957) introduced *Phacidiella coniferarum* Hahn, discussed its pathology, and gave a brief taxonomic history of *Phacidiella*. Smerlis (1962) found that the name *Phacidiella* had already been validly applied to a genus of Fungi *Anamorphosium* by Karsten (1884). Consequently, Smerlis rejected *Phacidiella* Potebnia as a later homonym, and provided a new generic name, *Potebniamyces* Smerlis. At the same time Smerlis introduced *Potebniamyces balsamicola* Smerlis, and gave an account of its taxonomy, morphology, and its unnamed anamorph.

Dennis (1968) placed *P. discolor* in the Cryptomycetaceae, and later, (Dennis 1978), discovered an earlier, valid epithet which meant that the fungus had to be called *P. pyri*. Korf (1973) maintained *Potebniamyces* in the Cryptomycetaceae.

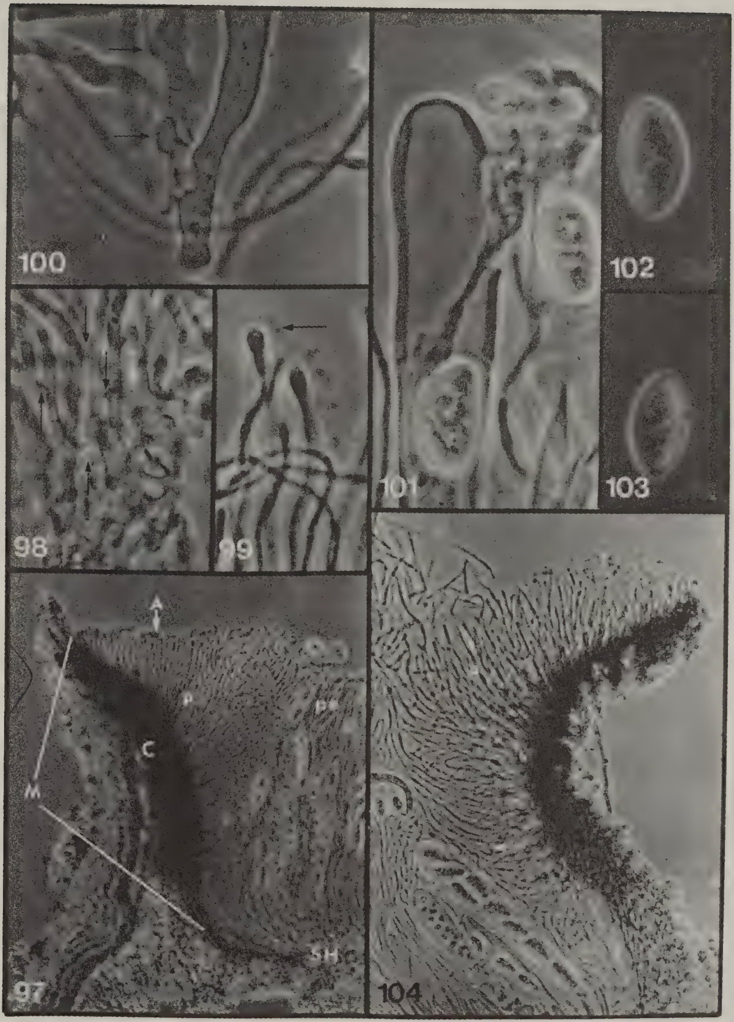
Potebniamyces has three species: *P. balsamicola*, *P. coniferarum*, *P. pyri*, and one variety, *P. balsamicola* var. *boycei* Funk (Funk 1970). While evaluating these, we found several important and previously unnoticed characteristics. We conclude that *Potebniamyces* as delimited by Smerlis (1962) is a heterogeneous assemblage held together on the basis of the reduced ascoma which develops beneath the bark of the host, and the ellipsoid, unicellular ascospores.

In the ascomycetes we have studied, such characteristics are unreliable indicators of species, much less families. We consider *P. balsamicola* var. *balsamicola*, *P. balsamicola* var. *boycei* and *P. coniferarum* referable to *Phacidium sensu stricto*. These species will be discussed in detail under *Phacidium*. Likewise, we exclude the anamorphs of these taxa from *Phacidiopycnis*.

Examination of the type material of *Potebniamyces pyri* revealed that this species, too, was poorly delimited by its authors. It is redescribed and illustrated here.

Potebniamyces pyri (Berk. & Br.) Dennis Figs. 97-104.
British Ascomycetes p. 231 (1978).
≡ *Stictis lecanora* (Schm. & Kunze) Fr. var. *pyri* Berkeley & Broome, Ann. Mag. nat. Hist. ser. 4(17): 144 (1876).
= *Phacidium discolor* Mouton & Saccardo, Syll. Fung. 8: 716 (1889).
≡ *Phacidiella discolor* (Mout. & Sacc.) Potebnia, Zeit. Pflanzenkrank. 22: 129 (1912).
≡ *Potebniamyces discolor* (Mout. & Sacc.) Smerlis, Can. J. Botany 40: 352 (1962).
= *Phacidium verecundum* Bomm., Rouss. & Sacc., Bull. R. Bot. Belg. 29: 233 (1891). *teste* Hoehnel (1917c).
= *Pseudophacidium atroviolaceum* Hoehn., Oesterr. Bot. Zeit. 55: 187 (1905). *teste* Hoehnel (1917c).
= *Cenangium strasseri* Rehm, Annls. Mycol. 13: 1 (1915). *teste* Hoehnel (1917c).
= *Ocellaria kirschsteiniana* Jaap, Verh. Bot. Ver. Brdbg. 64: 16 (1922). *teste* Arx & Mueller (1954).
≡ *Encoelia kirschsteiniana* (Jaap) Kirschst., Annls. Mycol. 36: 369 (1938). *teste* Petrak (1940).

Caulicolous and corticolous. Ascomata scattered to gregarious to densely crowded and confluent, initially immersed, ultimately erumpent, irregular in outline, 500-1500 X 500-1000 µm, the fungal covering opening to form a margin, exposing a dense hymenium of asci and paraphyses; fungal covering layer of dark brown to brown outer *textura globulosa* which becomes pale toward the interior, innermost layer of subcylindrical, branched, septate, hyaline,



Potebniamyces pyri. 97. V.S. of ascoma in region of the margin (M), with covering layer (C), periphysoids (P) in an amorphous matrix (A), and pseudo-epithecium (pe). x 125. 98. Paraphyses, arrows indicate points of anastomosis. x 1280. 99. Apices of paraphyses in mucilage (arrow). x 1280. 100. Proliferating croziers. x 1280. 101. Ascus apex (note thin wall at tip) and ascospores. x 1280. 102, 103. Two ascospores. x 1280. 104. Detail of margin, showing periphysoids (P) that frequently anastomose (arrows). x 310.

smooth-walled periphysoids up to 100 µm long, 2-3 µm wide, invested in mucilage and the tips agglutinated in an amorphous substance containing pale red-brown crystalline material. Hymenium red-brown in water, staining blue-green (KOH$^+$, green) in 2% aqueous KOH, composed of asci and paraphyses; 200-250 µm thick. Asci club-shaped, 8-spored, 125-150 X 12-18 ($\bar{x}$ = 130 X 14.5) µm, with a thin-walled, non-amyloid (I$^-$) apex. Ascospores usually uniseriate, subglobose to ellipsoid, non-septate, guttulate, hyaline to pale yellow, smooth-walled, (12-) 14-25 (-26) X 10-12 ($\bar{x}$ = 15 X 11) µm, mean length/width ratio = 1.4:1. Paraphyses abundant, subcylindrical, branched or simple, septate, hyaline, smooth-walled, up to 250 um long, 1.5-2.5 µm wide, often with inflated apices and agglutinated in a pale brown amorphous pseudoepithecium with some crystalline deposits.

Habitat: on bark of *Cydonia vulgaris*, *Pyrus communis*, and *P. malus*.

Known distribution: Europe; North America.

Specimens examined: in K, Holotype of Teleomorph, ex herb. M. C. Cooke 148, Shrewbury, England; in BPI, Anamorph in FH *sub Discula piri* (Fuckel) Hoehn. Hoehnel, Wiener-Wald, 1915-V-06; Laubert, Austria, 1918-I-30; P. P. Strasser, Austria, 1917-VI.

Several authors (Arx & Mueller 1954; Dennis 1968, 1978; Hahn 1957; Smerlis 1962) discussed the familial relations of *Potebniamyces*, but their conclusions were based on inadequate taxonomic evidence. Korf (1973) and Lanier et al. (1978) accepted *Potebniamyces* as delimited by earlier authors.

In Figs. 97-104, the type species of *Potebniamyces*, *P. pyri* is illustrated. The margin (Fig. 97, M) is immersed, and is composed of a thick, brown *textura globulosa* which is the fungal covering layer (C); the innermost layer is composed of branched, smooth-walled periphysoids (P) which often anastomose (Fig. 104, P, note the arrows) and are invested in an amorphous material (Fig. 97, A) with incrustations around the periphysoid apices in the apical area of the margin. Note that a pseudoepithecium (Fig. 97, pe) extends well above the asci. A shallow subhymenium (SH) is also present. The asci and paraphyses arise from the subhymenium. Anastomosis (Fig. 98, arrows) is common between adjacent paraphyses with inflated apices (Fig. 99) invested in a mucilaginous matrix (Fig. 99, arrow), and may represent points of nuclear migration. Such a system appears to be present in the Rhytismataceae (Morgan-Jones & Hulton 1977). In Fig. 100 (arrows) the penultimate cell of the crozier does not necessarily give rise to an ascus. The cell may remain dikaryotic and proliferate, forming croziers at successively higher levels.

Such variations of the crozier mechanism are common in the Ascomycetes. The system in *P. pyri* is reminiscent of that described for *Sclerotinia sclerotiorum* (Lib.) deBary and *S. trifoliorum* Erikss. (Mueller & Loeffler 1976), and may indicate a relationship with the Helotiales. The thin-walled ascus apex of *P. pyri* (Fig. 101) probably ruptures irregularly to release the unicellular ascospores (Figs. 102, 103), and is similar to that found in *Darkera abietis*, *D. parca* and *Rhabdocline pseudotsugae* subsp. *pseudotsugae*. Ascospore morphology is reminiscent of that in *D. abietis* and *D. parca*.

It could be argued that *Rhabdocline*, *Darkera*, and *Potebniamyces* are related. Other arguments could be advanced suggesting a relation between *P. pyri* and the Helotiales. Clearly, *P. pyri* does not have a massive stroma like that of *Cryptomyces maximus*, illustrated by Nannfeldt (1932). It seems reasonable to exclude *Potebniamyces* from the Cryptomycetaceae. However, we cannot confidently suggest another home for it. *P. pyri* has characteristics of the Phacidiaceae, Rhytismataceae, and the Dermateaceae of the Helotiales.

At this point, it seemed logical to see if information derived from the anamorph could resolve the situation. We examined the *Phacidiopycnis piri* anamorph of *Potebniamyces pyri*, using material from FH (herb. Hoehnel, specimen dated 1915-V-06).

Phacidiopycnis piri (Fuckel) Weindlmayr, Sydowia 17: 27 (1964).
≡ Cytospora piri Fckl., Jahrb. Ver. Natur. Nass. 15: 52 (1860).
≡ Myxosporium piri (Fckl.) Fckl., Symb. Mycol. p. 399 (1869).
≡ Discula piri (Fckl.) Hoehn., Mitt. Bot. Inst. Techn. Hochsch. Wien 3: 53 (1926).

Caulicolous and corticolous. Conidiomata scattered to gregarious, immersed, subepidermal, depressed globose to orbicular, papillate, non-ostiolate, raising the overlying host tissue into pulvinate swellings, ultimately erumpent, 500-1000 µm diam., multilocular, brown, dehiscent by irregular rupture of the apical wall, wall of brown textura globulosa to textura epidermoidea above, up to 50 µm thick, pale brown below; walls between locules composed of pale yellow-brown textura prismatica, 15-20 µm thick, subhyaline toward the hymenium. Conidiogenous cells phialides, lining the locules completely, subcylindrical, lageniform to ampulliform, straight or irregularly bent, hyaline, smooth-walled, 5-12.5 X 2.5-3.5 ($\bar{x}$ = 8 X 3) µm, proliferating percurrently 1-3 times, invested in mucilage. Conidia blastic-phialidic, subglobose to obovoid, guttulate, amerosporous, with a truncate base, hyaline to pale yellow, smooth-walled, 9-14 X 5.5-9 ($\bar{x}$ = 11.5 X 7.5) µm, mean length/width ratio = 1.6:1.

Sutton (1980) provided a description, and Nag Raj & DiCosmo (1981) published an illustration and generic diagnosis of Phacidiopycnis piri, and Phacidiopycnis, respectively. Sutton (1980) interpreted conidiogenesis as enteroblastic-phialidic. Annellidic (percurrently proliferating) conidiogenous cells were illustrated by Nag Raj & DiCosmo (1981).

The anamorph may occur intermixed with the teleomorph. The multiloculate conidiomata are composed of dark brown, outer textura globulosa which becomes paler toward the interior. The locule walls are derived from these tissues, and are invested in mucilage. Conidia are non-septate, and obovoid with a truncate base. These characters, coupled with knowledge of the teleomorph, indicate that Phacidiopycnis piri is not closely related to either Ceuthospora or Apostrasseria, which contain the anamorphs of known Phacidiaceae.

Potebniamyces pyri and its anamorph are associated with a die-back and canker of apple trees (Southee & Brooks 1926). Yet Hahn (1957), Smerlis (1962) and Funk (1969, 1970) all discussed Potebniamyces spp. that were pathogenic to conifers. It is now apparent that these authors had studied caulicolous Phacidium spp. Consequently, Potebniamyces sensu DiCosmo, Nag Raj & Kendrick is seen to be monotypic, containing only P. pyri, and occurs only on Cydonia sp., Pyrus communis and P. malus.

Recently, Pirozynski & Weresub (1979) attempted to elucidate the biogeography of Ascomycetes. In their stimulating discourse, they referred to the Cryptomycetaceae and found that members of this family "...do not occur on hosts older than Pinaceae (Potebniamyces on Pinus, Pseudotsuga and Tsuga)." However, our studies indicate that P. pyri may be more recently evolved, and may be confined to members of the Rosaceae. The 'Potebniamyces spp.' on members of the Pinaceae referred to by Pirozynski & Weresub (op. cit.) are no doubt species of Phacidium,

20. Pseudophacidium Karsten.

Type species: P. ledi (Alb. & Schw.:Fr.) Karst.
Anamorph: Myxofusicoccum ericeti (Sacc.) Petrak.

Karsten (1885) introduced Pseudophacidium for P. ledi, and included P. callunae (Karst.) Karst., P. degenerans (Karst.) Karst., and P.

rugosum (Fr.:Fr.) Karst. in the genus. Rehm (1896) studied *Pseudophacidium* and added *P. betulae* (Rehm) Rehm, *P. microspermum* (Fuckel) Rehm, *P. necans* Rehm, *P. propolideum* Rehm, *P. rhododendri* (Rehm) Rehm, and considered *P. decorticans* Rehm referable to *Cenangium farinaceum* (Pers.) Rehm. Sydow in Sydow, Sydow & Butler (1911) described *P. indicum* Syd.

Hoehnel (1917c) monographed *Pseudophacidium*, and introduced *Myxophacidiella* Hoehnel, and *Myxophacidium* Hoehn. as segregates from *Pseudophacidium*. The fungus Hoehnel (1917c) described as *P. ledi* is an apparently entirely different and unrelated species. There is no indication that Hoehnel ever studied the type or authentic material of *Pseudophacidium*. His illustration of *P. ledi* is vaguely reminiscent of a *Lophodermium* sp. Such a misconception may have led Hoehnel to introduce *Myxophacidiella* and *Myxophacidium*. *Myxophacidiella* included *M. betulae* (Rehm) Hoehn., *M. callunae* (Karst.) Hoehn., *M. microspermum* (Fuckel) Hoehn., and *M. rehmii* (Feltgen) Hoehn. *Myxophacidium* contained *M. degenerans* (Karst.) Hoehn. and *M. rhododendri* (Rehm) Hoehn. *P. atroviolaceum* Hoehn. was found to be identical with *Phacidium discolor* Mout. & Sacc. Hoehnel found that anamorphs of both *Myxophacidiella* and *Myxophacidium* were referable to *Myxofusicoccum* Diedicke (Diedicke 1912).

Petrak (1922) described *Myxophacidiella sydowiana* Petr. and believed that *Myxophacidiella* represented an intermediate form between the Dothioraceae and Phacidiaceae. He proposed to group species having covering layers with no preformed lines of dehiscence, (thus rupturing irregularly to expose the hymenium) in the Myxophacidiaceae. Later, however, Petrak (1931) concluded that *Myxophacidiella* and *Myxophacidium* were congeneric.

Nannfeldt (1932) referred *Myxophacidiella* to the Pseudosphaeriaceae and found *Myxophacidium* to be best maintained in the Phacidiaceae. He also transferred *Pseudophacidium salicis* Feltgen to *Pyrenopeziza*.

Terrier (1942) provided the first 'modern' treatment of the Phacidiaceae. He considered *Pseudophacidum* (*ut Pseudophacidium* (Karsten) Hoehnel) distinct from *Myxophacidiella* and *Myxophacidium*. These last two genera were referred to the Phacidiaceae *sensu* Terrier, and *Pseudophacidium* was redisposed in the Hypodermataceae.

Ramakrishnan (1951) introduced *Pseudophacidium photiniae* Ramak. & Sriniv.

Arx & Mueller (1954) treated the Phacidiaceae, and, like Petrak (1931), considered *Myxophacidiella* and *Myxophacidium* to be congeneric. They also believed that these genera were referable to *Pseudophacidium*, as we do. Arx & Mueller provided an extensive synonymy and diagrammatic illustration of *P. ledi*.

Most recently, Egger (1968) studied the biology and morphology of *Pseudophacidium* and provided a taxonomic history of the genus, including an extensive synonymy for *P. ledi*. Her nomenclator cannot be fully accepted. Egger (*op. cit.*) included *Hysterium degenerans* Fries (Fries 1822) in her synonymy. She did not recognize that *H. degenerans* is the basionym of *Sporomega* Corda (Corda 1842). Egger (1968) also treated *P. gaeumannii* (Mueller 1963), *P. necans* Rehm, and *P. piceae* Mueller (Mueller 1963). Much-needed cultural data were provided for these species. Egger established genetic connections in culture between *P. ledi* and *Myxofusicoccum ericeti*, and between *P. piceae* and a presumed *Myxofusicoccum* sp. However, Egger failed to characterize *Pseudophacidium* adequately because she included at least one discordant element (*P. gaeumannii*) in the genus. This species is referable to *Phacidium sensu stricto*, and we will discuss it later.

Funk (1980) described *Pseudophacidium garmanii* Funk and its *Myxofusicoccum* anamorph from branches of *Picea glauca* in British Columbia, Canada. He was able to prove, using pure culture technique, mass ascospore and mass conidial inoculations, that the two morphs were genetically linked. *P. garmanii* is undoubtedly closely related to *P. piceae*, and the respective anamorphs are also clearly congeneric. However, we doubt that the anamorphs belong in *Myxofusicoccum*.

No less than 17 species have been described in *Pseudophacidium* since its inception, but no modern monographic account of the genus has appeared. Korf (1973) believed *P. ledi* to belong in the Phacidiaceae. However, our studies indicate that *Pseudophacidium* may occupy an isolated position near the Dermateaceae.

It was not the intention of this study to provide a monograph of *Pseudophacidium* and its anamorphs, although this is urgently needed. Since Arx & Mueller (1954), and Egger (1968) have provided extensive synonymies which we are not prepared to accept, we shall provide a limited nomenclator for *P. ledi* and redescribe it here.

The description provided for *P. ledi* is derived from a limited number of specimens, some of which were in a poor state of preservation. Future studies of more representative collections may well necessitate changes to our description.

Pseudophacidium ledi (Alb. & Schw.:Fr.) Karsten Figs. 105-111.
Acta Soc. Fauna Fl. Fenn. 2(6): 157 (1885).
≡ *Xyloma ledi* (Alb. & Schw.) Schmidt, in Kunze &Schmidt, Mycol. Hefte, p. 31 (1817).
≡ *Phacidium ledi* (Alb. & Schw.):Fr., Syst. Mycol. p. 574 (1823).
(sanctioned, ICBN, Art. 13.1(f)).

Caulicolous. Ascomata scattered to gregarious, often crowded, initially immersed, in outer cortical layers, raising the overlying host tissue into swellings which ultimately rupture, exposing the ascomata proper which are oblong, hemispherical to irregularly pulvinate, black, carbonaceous, usually discrete, 500-1500 X 500-1000 (-1500) µm; wall of brown *textura globulosa* up to 40 µm thick above, 15-25 µm thick in lateral walls, becoming pale brown toward the interior; innermost layer of subglobose, subhyaline cells with gelatinizing outer walls, invested in mucilage. Hymenium up to 100 µm thick, of asci only; subhymenium hyaline, up to 10 µm thick, of *textura intricata*; basal stroma pale brown, up to 150 µm thick, of pseudoparenchymatous cells with gelatinizing outer walls. Asci club-shaped, 8-spored, 75-100 X 8-12 ($\bar{x}$ = 85 X 10) µm, flattened at the non-amyloid (I^-) apex. Ascospores irregularly biseriate, oblong-ellipsoidal, straight or curved, hyaline, smooth-walled, 8-13 X 4-5 ($\bar{x}$ = 10 X 4.5) µm, mean length/width ratio = 2.2:1.

Habitat: on branches of *Ledum palustre*.

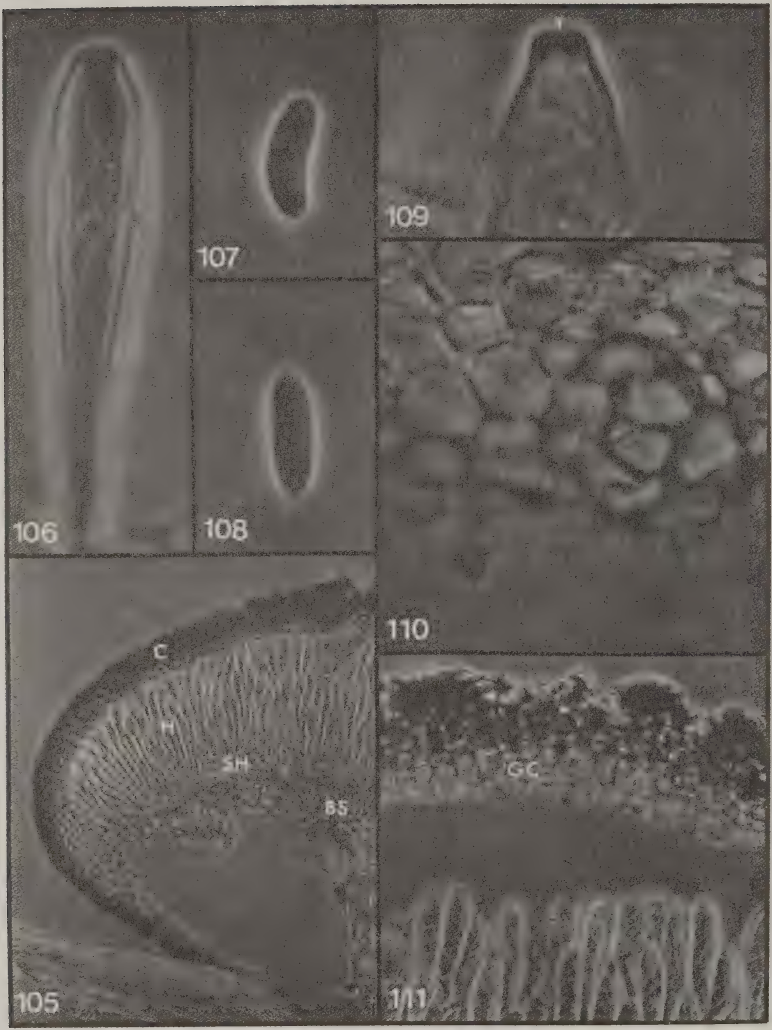
Known distribution: Europe; North America.

Specimens examined: DAOM 129880, E. Smerlis, St. Louis-de-Blandford, Quebec, Canada, 1966-IV-20; DAOM 105935, R. A. Shoemaker, Mt. Revelstoke, B.C., Canada, 1964-VII; in S, Rabenhorst Herb. Mycologicum Exs. Ed. 2: 520, Lasch, Diresen, 1857-IV.

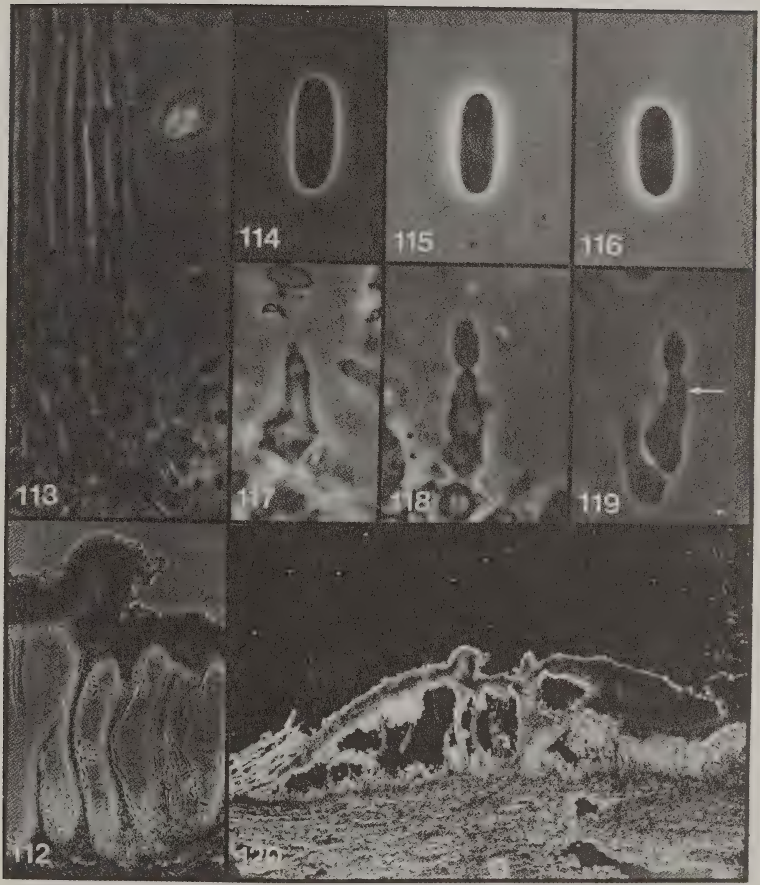
Arx & Mueller (1954) and Eriksson (1970) have indicated that this apparently common and cosmopolitan fungus is polyphagous on members of the Ericaceae. The fungus is found wherever its hosts are present in the temperate and boreal zones of Europe and North America.

The anamorphs of *Pseudophacidium* spp. are referable to *Myxofusicoccum*. No author has yet provided a modern account of that anamorph-genus. Sutton (1977) suggested that *Myxofusicoccum* is a later name for *Pseudodiscula* Laubert. However, no recent account of that genus exists either. In an effort to stimulate future studies on these poorly known genera, we include an analysis of *M. fraxini* Jaap. We have no doubt that *M. fraxini* is congeneric with *M. obtusulum* (Sacc. & Briard) Diedicke, the lectotype species of *Myxofusicoccum*.

Myxofusicoccum fraxini Jaap Figs. 112-120.



Pseudophacidium ledi. 105. V.S. of an ascoma showing covering layer (C), hymenium (H), subhymenium (SH) and basal stroma (BS). x 1280. 106. Immature ascus with thickened apex. x 770. 107, 108. Mature ascospores. x 770. 109. Ascus apex, with mature (I^-) dehiscence mechanism (arrow-head). x 1280. 110. Detail of fungal covering layer of *textura globulosa*. x 1280. 111. Fungal covering layer and asci, with gelatinizing cells (GC) lining the interior of the cover. x 310.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Myxofusicoccum fraxini. 112. Detail of multiloculate conidioma. x 130. 113. Detail of wall of textura porrecta. x 770. 114-116. Conidia. x 1280. 117-119. Conidiogenous cells, arrow (Fig. 119) indicates percurrent proliferation. x 1280. 120. Vertical section of a conidioma. x 50.

Fungi Selecti Exs. no. 698 (1913).

Corticolous. Conidiomata pycnidioid, stromatic, scattered, gregarious to densely crowded, immersed, discoid to orbicular, raising the overlying host tissue into elliptical to irregular pulvinate swellings which ultimately become erumpent by irregular longitudinal rupture of the overlying host tissue, 500-2000 X 300-500 µm, plurilocular, brown, no definite ostioles present, up to 250 µm high, dehiscent by rupture of the apical fungal wall, area of dehiscence bordered by a brown, powdery mass of pseudoparenchymatous cells. Outer walls pseudoparenchymatous, of brown *textura globulosa* usually 15-50 µm thick, but up to 80 µm thick, becoming subhyaline toward the hymenium. Individual locules separated by hyaline walls of *textura porrecta* up to 200 µm long, individual hyphal elements 1.5-2 µm wide, with gelatinizing outer walls; basal stroma of the conidioma of pale brown *textura epidermoidea* up to 10 µm thick. Conidiogenous cells phialides, completely lining the locules, though fewer toward the apex, lageniform to subulate, often ampulliform, hyaline, smooth-walled, 6-12 X 2.5-4 ($\bar{x}$ = 10 X 3) µm, invested in a copious mucilaginous matrix, and proliferating percurrently once or twice. Conidia blastic-phialidic, ellipsoid to oblong, sometimes subreniform, ends rounded, guttulate, hyaline, smooth-walled, 7-10.5 X (2.5-) 3 ($\bar{x}$ = 9 X 3) µm, mean length/width ratio = 3:1, collecting in a cream coloured mucilaginous mass around the area of dehiscence.

Habitat: on twigs of *Fraxinus excelsior*.

Known distribution: Austria.

Specimens examined: in S, Isotype of *M. fraxini*, O. Jaap, Fungi Selecti Exs. no. 698, O. Jaap, Brandenburg, 1913-XII-23.

Sydow in Sydow, Sydow & Butler (1911) described *Pseudophacidium indicum* Syd. (Figs. 121-128) for a fungus found on dead branches in India. Examination of the type material, Herb. Crypt. Ind. Orient. no 1339 in S has revealed that the fungus was misidentified and must be excluded from *Pseudophacidium*.

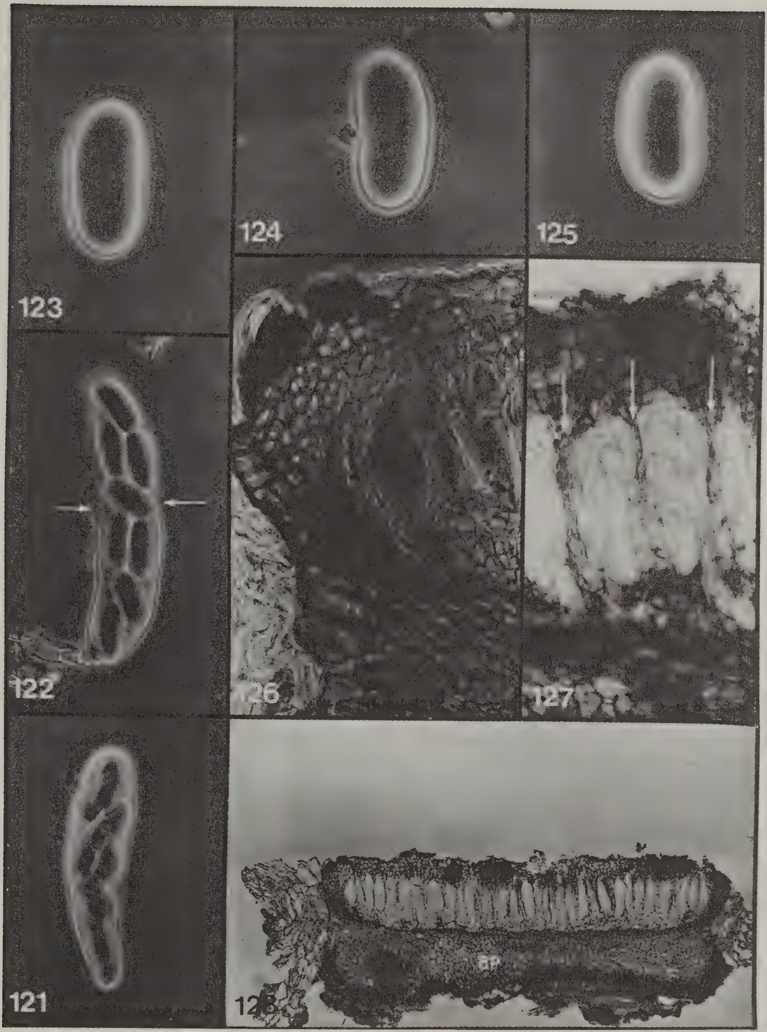
The fungus is corticolous, ascomata are erumpent, discoid, black and carbonous. In vertical section (Fig. 128) the ascomata are composed of brown *textura globulosa* which forms a thick basal pad (Fig. 128, BP) from which asci arise in individual locules (Figs. 126, 127). As the asci mature and grow, the internal tissue of the ascoma is compressed and pushed upward and outward to form walls that separate the individual locules. Most significantly, the asci are bitunicate (Fig. 122). This new information, with Sydow's original description, indicates that the taxon can be best maintained in *Bagnisiella* Spegazzini (Myriangiales). Therefore, *Bagnisiella indica* (Syd. in Syd. & Butler) DiCosmo, Nag Raj & Kendrick comb. nov. (≡ *Pseudophacidium indicum* Syd. in Syd. & Butler) is proposed.

21. *Rhabdocline* Sydow, in Sydow & Petrak.

Type species: *R. pseudotsugae* Sydow subsp. *pseudotsugae*.
Anamorph: *Rhabdogloeum pseudotsugae* Syd.

In a well-documented study, Brandt (1960) presented the history and pathology of *Rhabdocline* needle-cast in New York State. *R. pseudotsugae* is an obligate parasite on leaves of young *Pseudotsuga menziesii* (Mirb.) Franco. The disease causes severe defoliation in the N.W. United States and in Christmas tree plantations and nurseries in N.E. United States and Europe. Brandt described symptoms and development of both disease and fungus.

Parker & Reid (1969) provided a monographic account of *Rhabdocline*. They found that *R. pseudotsugae* was an aggregate of two species, easily separated on differences in ascus structure. Parker & Reid (1969) introduced *R. weirii* subsp. *obovata* Parker & Reid, and *R. pseudotsugae* subsp. *epiphylla* Parker & Reid. These authors discussed the significance of the



Bagnisiella indica. 121. Ascus with 8 ascospores. x 310. 122. Bitunicate ascus with inner wall extended prior to dehiscence. x 310. 123-125. Mature ascospores. x 1280. 126, 127. Detail of ascomata, showing locules and compressed stromatic cells (arrows) separating locules. x 310. 128. V.S. of ascoma, showing basal pad (BP). x 65.

disease, the iodine reaction of asci, and spore maturation. *Rhabdocline* was placed in the Hemiphacidiaceae, but with qualification. Parker & Reid found that *R. pseudotsugae* was best retained in the Hemiphacidieae, while *R. weirii* had the essential features of the Sarcotrochileae (Hemiphacidiaceae). Parker and Reid thus questioned the utility of tribes in the Hemiphacidiaceae.

We accept the valid arguments made by Parker & Reid. A monographic reappraisal of the Hemiphacidiaceae and related anamorphs is needed.

Millar & Minter (1980a), summarizing what is known about the pathology of *R. pseudotsugae*, found that the ascospores were surrounded by a gelatinous sheath. This provides a clue to the relationships of *Rhabdocline*, which may lie with the Rhytismataceae.

22. *Schizothyrioma* Hoehnel.

Type species: *S. ptarmicae* (Desm.) Hoehn.
Anamorph: unknown.

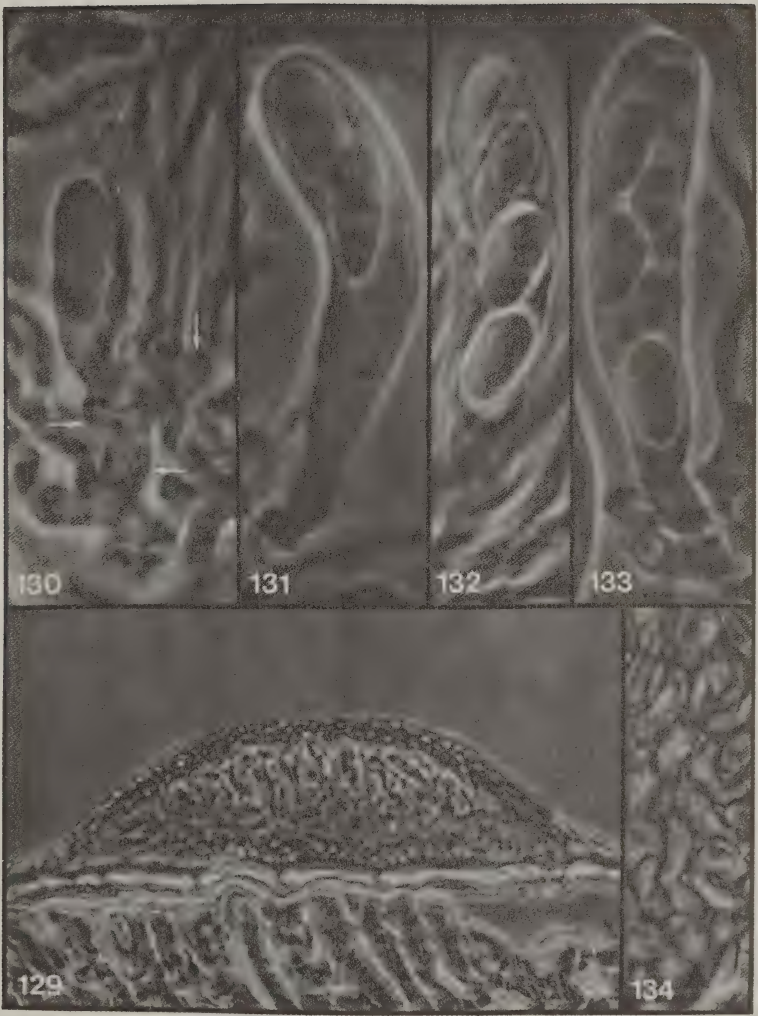
In 1826, Desmazieres issued *Labrella ptarmicae* (*in scheda*), as no. 189 of his first series of Plantes Cryptogames du Nord de la France, for a fungus on *Achillea ptarmica*. Later, Desmazières (1849) transferred *L. ptarmicae* to *Schizothyrium* Desm.

Rehm (1896) placed *Schizothyrium ptarmicae* (Desm.) Desm. in the Euphacidiaceae. Hoehnel (1917a) erected the monotypic genus *Schizothyrioma* for *S. ptarmicae* (Desm.) Hoehn., and pointed out that the ascomata were subcuticular (Fig. 129) and stromatic. He placed the genus in the Leptopeltidaceae (*ut* Leptopeltineen v. H.) of the Loculoascomycetes.

Mueller & Arx (1961) disposed *S. ptarmicae* in the Phacidiaceae, because it had unitunicate asci. At that time these authors believed that the Phacidiaceae did not possess true paraphyses, an apparent oversight. Dennis (1968) referred *Schizothyrioma* to the Phacidiaceae because it did not fit into either the Cryptomycetaceae or Hypodermataceae.

More recently, Holm (1971) provided a detailed taxonomic history of *S. ptarmicae*, and introduced a second species of *Schizothyrioma*, *S. aterrimum* (Karst.) L. Holm. Holm found that *S. aterrimum* had an amyloid (I$^+$) dehiscence ring in the ascus apex, although this feature is absent from *S. ptarmicae*, the type species (Figs. 131-133). Holm also provided some photographic documentation of *S. aterrimum*. This species produces ascomata that are initially subcuticular, ultimately appearing superficial. The external stromatic tissue is of brown *textura globulosa*, and asci arise from a hyaline to subhyaline subhymenium. Holm found that the asci, ascospores and paraphyses of *S. aterrimum* were similar to those of *Pseudopeziza sensu lato* (Pseudopezizoideae, Helotiales). We found that the paraphyses of *S. ptarmicae* are not apically inflated as Holm illustrated. Ultimately, Holm (1971) emphasized the peculiar habits of *S. aterrimum* and *S. ptarmicae*, and the isolated position in the Pseudopezizoideae of *Schizothyrioma*.

Our studies of specimens of Desm. Plant. Crypt. France ser. 1: 189 (1826) located in FH, illustrated in Figs. 129-134, and Rabenhorst Fungi Europaei Exs. 1714 (1873), suggest that *S. ptarmicae* is even more peculiar relative to the Phacidiaceae than Holm thought. The subcuticular ascoma is composed of brown *textura epidermoidea* that forms a covering over the asci. In surface view the covering is of thick-walled hyphal elements firmly agglutinated (Fig. 134). The club-shaped asci arise from a proliferating system of croziers (Fig. 130, arrows), have non-amyloid (I$^-$) apices, and may produce 2, 4 or even 6 ascospores (Figs. 131-133). Asci with 8 incipient ascospores were also noted. *Schizothyrioma* is undoubtedly heterogeneous as treated by Holm (1971). Holm's *S. aterrimum* is clearly not congeneric with the type species, *S. ptarmicae*. Holm's species fits in the Pseudopezizoideae, and is allied to *Leptotrochila* Karst. *S. ptarmicae* fits into neither the Pseudopezizoideae nor the Phacidiaceae *sensu* DiCosmo, Nag Raj & Kendrick, and may belong in the Leptopeltidaceae as Hoehnel



Schizothyrioma ptarmicae. 129. V.S. of ascoma. x 205. 130. Percurrently proliferating croziers (arrows) and young ascus. x 1280. 131. 2-spored ascus. x 1280. 132. 4-spored ascus. x 1280. 133. 6-spored ascus. x 1280. 134. Detail of covering layer of ascoma. x 1280.

originally suggested. However, we cannot place it with any confidence.

23. Sphaeropezia Saccardo.

Type species: S. alpina (Sacc.) Sacc.
Anamorph: unknown.

Saccardo (1882) introduced Heterosphaeria alpina Sacc. for a fungus on Dryas octopetala. In 1884, Saccardo made H. alpina the type of his new genus Sphaeropezia, and referred it to the Patellariaceae. Later, however, Saccardo (1889) placed it in the Phacidiaceae.

Rehm (1896) also placed S. alpina in the Phacidiaceae, and described "S. empetri (Fuckel) Rehm," S. andromedae (Fr.) Rehm, and S. vaccinii Rehm. Rehm (1910) subsequently introduced S. arctostaphyli (Karst.) Rehm.

Hoehnel (1917a) revised Sphaeropezia, maintained in the Phacidiaceae, and introduced the segregate genus Eupropolella Hoehn., for S. vaccinii (Rehm) Hoehn., which he placed in the Stictidaceae. Clements & Shear (1931) also referred Sphaeropezia to the Phacidiaceae, and indicated that S. vaccinii was the type. However, Saccardo (1884) had indicated that Sphaeropezia was based on S. alpina.

Mueller & Arx (1955) transferred S. alpina to Phacidium, thus placing it firmly in the Phacidiaceae. However, they left the remaining three species in limbo. Dennis (1968, 1978) accepted Mueller & Arx's (1955) decision and maintained Sphaeropezia in the Phacidiaceae.

The Sphaeropezia complex was examined by Eriksson (1970), who accepted Eupropolella and considered S. andromedae and S. arctostaphyli synonyms of E. vaccinii. Eriksson (1974) considered S. empetri (Rehm) Rehm as providing the type of a second segregate genus, Arwidssonia B. Erikss., but was unable to dispose the genus in any known family of Pyrenomycetes.

Holm (1979) re-examined the type species (S. alpina) of Sphaeropezia. He found that it was actually Odontotrema alpinum (Sacc.) L. Holm (Helotiales). With Holm's (1979) treatment the turbulent history of Sphaeropezia was at an end. Sphaeropezia is now considered a superfluous name for Odontotrema Nylander.

24. Therrya Penzig & Sacc.

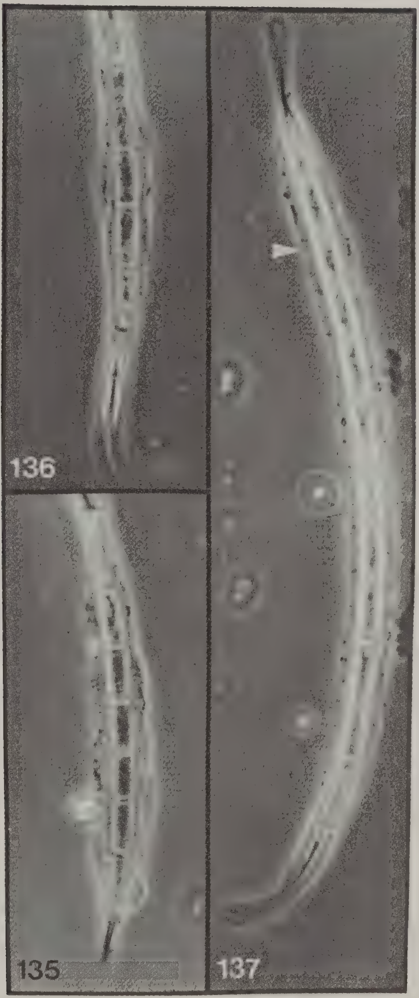
Type species: T. pini ((Alb. & Schw.) Schm.:Fr) Hoehn.
Anamorph: Colpomella pini Hoehn.

The early nomenclatural and taxonomic history of Therrya has already been admirably documented by Gremmen (1960), and by Reid & Cain (1961), so need not be repeated here. Gremmen (1960) studied T. pini in culture and proved the genetic connection between T. pini and its anamorph, C. pini. Reid & Cain (1961) made an extensive study of both European and North American collections of T. pini and T. fuckelii (Rehm) Kujala (Kujala 1950), the two known species. They unravelled the complex nomenclatural history, provided illustrations and discussed both species. Like Nannfeldt (1932), Reid & Cain (1961) could not assign Therrya to any known ascomycete family but doubted that it belonged in the Rhytismataceae.

Dennis (1968, 1978) put Therrya in the Phacidiaceae with other miscellaneous genera that he could not place in either the Cryptomycetaceae or Rhytismataceae. Korf (1973) keyed Therrya out in the Coccophacidieae of the Phacidiaceae.

Lanier et al. (1978) accepted Therrya in the Phacidiaceae, and stated categorically that the genus was not a member of the Rhytismataceae.

Dr. M. A. Sherwood generously sent us a good specimen of T. fuckelii on Pinus resinosa from Cape Cod, Massachusetts. Our observations agree in



Therrya fuckelii. 135, 136. Basal portion of ascospores enveloped in mucilaginous coats. x 770. 137. Mature ascospore with mucilaginous coat (arrow-head) extending to the beginning of the apical and basal extremities. x 770.

most respects with those of Gremmen (1960), Kokko & Shoemaker (1974) and Reid & Cain (1961). However, we found that the margin of the ascoma was composed of dark brown to black outer *textura globulosa*, becoming paler and predominantly *textura epidermoidea* toward the interior, with the innermost layer of short, smooth-walled, hyaline periphysoids invested in mucilage. The subhymenium is of hyaline to pale yellow *textura angularis*, and the basal stroma is of dense *textura intricata* with irregularly swollen hyphae that have gelatinizing outer walls invested in a gel. The non-amyloid, mature, ascal apices were 'dimpled' at their centres, and this depression represents the dehiscence mechanism.

Bellemère (1975) presented a transmission electron micrograph of the ascus apex of *T. fuckelii* and showed that the apex was slightly thickened. His photomicrograph also showed an electron-opaque area at the centre of the apex. We interpret this as the area that will ultimately form the dehiscence mechanism. Most significantly, our slide preparations of *T. fuckelii* in dilute aqueous methylene blue showed that the ascospores were enveloped in mucilaginous coats (Figs. 135-137, arrows), contrary to Kokko & Shoemaker's (1974) findings.

The anamorph-genus *Colpomella* has been connected with *Colpoma* of the Hypodermales (Hennebert & Bellemère 1979), and this provides another useful indicator to the family affinities of *Therrya*, which has a *Colpomella* anamorph.

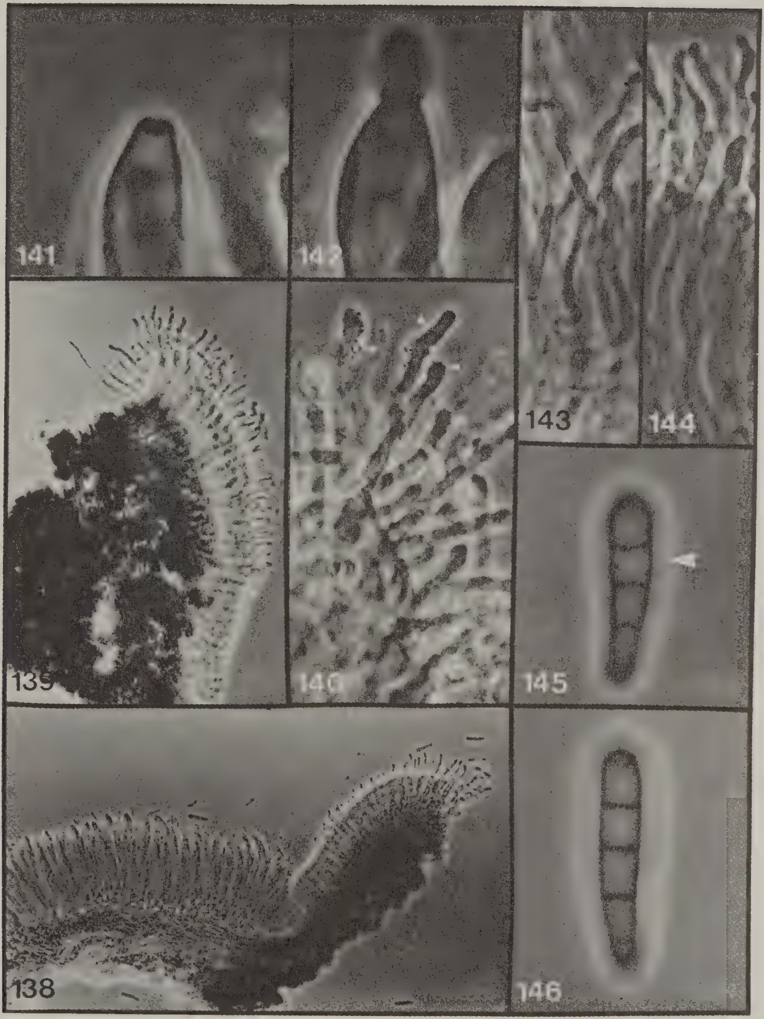
These features clearly support Sherwood's (1980) hypothesis that *Therrya* can be accommodated in the Rhytismataceae near the lignicolous species of *Coccomyces*.

SPECIES OF UNCERTAIN AFFINITY

Twenty-one genera have thus far been excluded from the Phacidiaceae *sensu* DiCosmo, Nag Raj & Kendrick, and shown to belong in other families on the basis of morphological and developmental features. Recently, Dr. M. A. Sherwood brought to our attention *Odontotrema rhopalospermum* Kirscht. (Kirschstein 1938), on culms of *Phragmites communis*. This fungus, which is illustrated in Figs. 138-146, clearly shares features with both Phacidiaceae and Rhytismataceae. A description of *O. rhopalospermum* derived from Smarod's Fungi Latvici Exsiccati no. 926 in FH and fresh collections is presented.

Odontotrema rhopalospermum Kirscht. Figs. 138-146.
Annls. Mycol. 36: 377 (1938).

Caulicolous. Ascomata scattered to gregarious, often confluent, circular to elongate-ellipsoid in outline, dark brown to black, initially immersed, subcuticular, pulvinate; ultimately the fungus covering layer splits irregularly to expose the plane, amber to pale yellow hymenium; 300-1000 X 300-600 µm. Overlying fungal tissue of dark brown to black, outer, carbonaceous, pseudoparenchymatous cells arising from a *textura porrecta* of brown, septate, verruculose hyphae, differentiating into a pale brown *textura oblita* with adjacent cells frequently anastomosing in the lower portions, becoming hyaline toward the interior and with an innermost layer of numerous simple or rarely branched short, hyaline, periphysoids with slightly swollen, rounded apices invested in mucilage in lower half of covering layer; periphysoids in upper areas up to 40 µm long and 2-2.5 µm wide, sparsely septate, with rounded apices and bearing minute incrustations. Hymenium up to 62 µm thick, composed of asci and paraphyses; subhymenium 15-25 µm thick, composed of hyaline to pale yellow *textura oblita*. Asci club-shaped, 8-spored, flattened in the region of the amyloid (I^+) apical dehiscence ring, 40-60 X 7-9 ($\bar{x}$ = 55 X 7.5) µm. Ascospores biseriate, shortly clavate, ends rounded, 3-septate, hyaline, smooth-walled, 15-22 X 3-4 ($\bar{x}$ = 18 X 3.5)



Odontotrema rhopalospermum. 138. V.S. of an ascoma. x 125. 139. Detail of covering layers. x 300. 140. Detail of periphysoids, arrow-heads indicate incrustations. x 1280. 141. Ascus apex (I^+) with prominent apical dehiscence mechanism. x 1280. 142. Mature ascospore escaping from an ascus. x 1280. 143. Septate paraphyses. x 1280. 144. Irregularly swollen, septate paraphyses. x 1280. 145, 146. Mature ascospores, with mucilaginous coats (arrow-head). x 1280.

µm, mean length/width ratio = 5.1:1, enveloped in a mucilaginous sheath. Paraphyses irregularly subcylindrical, usually simple, sometimes branched below, septate, 55-62 X 1.5-2 µm, apices rounded and slightly irregularly inflated, often with minute incrustations and enveloped in mucilage.

The covering layer of *O. rhopalospermum* is composed primarily of hyphal tissues (*textura porrecta* and *textura oblita*), a feature often found in the Rhytismataceae. The anatomy of the margin of *O. rhopalospermum* (Figs. 138, 139) is not unique to this species, occurring also in *Naemacyclus pinastri* (Fig. 74). The peculiar, roughened periphysoids (Fig. 140) are also present in both taxa. The paraphyses of *O. rhopalospermum* (Figs. 143, 144) are often irregularly swollen. The ascospores are invested in a mucilaginous sheath (Figs. 145, 146). These features suggest a kinship with the Rhytismataceae. However, the amyloid (I^+) apical dehiscence mechanism in asci of *O. rhopalospermum* makes classification of the species difficult because this characteristic is typical of the Phacidiaceae *sensu* DiCosmo, Nag Raj & Kendrick, and absent from the Rhytismataceae.

Morphological features like those of *O. rhopalospermum* are found in the Dermateaceae (Helotiales), Phacidiaceae *sensu* DiCosmo, Nag Raj & Kendrick (Helotiales) and the Rhytismataceae (Rhytismatales). A fungus with the combination of features found in *O. rhopalospermum* does not sit well in any of these families, although a relationship between them could be argued. *O. rhopalospermum* could be retained in the Rhytismataceae, but for its amyloid ascus dehiscence mechanism. Perhaps discovery of the anamorph would clarify the proper systematic position of *O. rhopalospermum*.

Recently, one of us (T.R.N.) has found a species of *Libartania* Nag Raj (Nag Raj 1979), intimately associated with ascomata of *O. rhopalospermum*. This *Libartania* anamorph is not typical of either the Rhytismataceae or the Phacidiaceae.

PHACIDIACEAE *sensu* DiCosmo, Nag Raj & Kendrick

The modern concept of the Phacidiaceae *auct*. sprang from Hoehnel's (1917b) radical reorganization of the Hypodermataceae and Phacidiaceae together with some genera in the Phacidiales Hoehn. He divided this order into six families, based mainly on the position of the ascoma within the host. The two families that concern us here were delimited as follows:

1. Phacidiaceae *sensu* Hoehn.: ascomata occurred under the epidermis, on leaves and twigs, and in one genus were erumpent from the surface of decorticated wood.
2. Phacidiostromataceae *sensu* Hoehn.: ascomata occupied the entire leaf thickness, deforming the epidermis; or developed in and under the epidermis of stems, extending deeply into the host tissues and deforming the epidermal cells.

This system brought unrelated genera together. *Phacidium* and *Odontotrema* were considered close relatives in the Phacidiaceae. Species now regarded as congeneric were segregated into different genera and families (*viz*. *Phacidiostroma* and *Phacidium*).

Hoehnel's classification has not been accepted by modern authors, mainly because it was based on 'artificial' criteria that are no longer considered familial characters and do not reflect phylogeny. However, more recent schemes have proved no better than Hoehnel's, each including some unrelated taxon in the group. We have stressed the coelomycetous anamorphs of the Phacidiaceae. Using these it has been possible to set the limits of species, genera and the family more accurately.

Greville (1827) had the earliest inklings of this concept when he described and illustrated two species of *Ceuthospora* and believed that *C. phacidioides* was the anamorph of *Phacidium multivalve*.

Looking at the 'phacidialean' group today, we see that its limits have been narrowed and its ordinal status is no longer recognized. It remains, in its narrowest interpretation, a family from which all hysteriaceous, rhytismataceous, and stictidiaceous genera have been removed, and it may thus be characterized as follows:

Phacidiaceae Hoehnel, char. emend. DiCosmo, Nag Raj & Kendrick.
Hoehnel, in Bot. Ges. 25: 419 (1917b).
= Phacidiostromataceae Hoehnel *pro parte*, Hoehnel in Bot. Ges. 25: 420 (1917b).

Foliicolous or caulicolous. Ascomata usually circular, initially immersed, subcuticular, subepidermal to subhypodermal, ultimately erumpent, overlying host and fungal tissues raised into irregular swellings, and splitting open irregularly by teeth, or longitudinally to expose the hymenium; overlying fungal tissue of vertically oriented cells forming a *textura globulosa* or *textura intricata*; innermost layer of smooth-walled periphysoids invested in mucilage. Hymenium of asci and true paraphyses; subhymenium of *textura angularis* to *textura epidermoidea*; basal stroma present or absent; when present, of *textura angularis*, *textura epidermoidea* or *textura globulosa*. Asci arising from croziers, club-shaped, 4- or 8-spored, with an amyloid (I^+) dehiscence ring (in Melzer's reagent). Ascospores non-septate, ellipsoid or irregularly ellipsoid, straight or curved, without gelatinous coats or appendages. Paraphyses branched or simple, septate, hyaline, invested in mucilage, with adjacent paraphyses frequently anastomosing.

Anamorphs, where known, occurring with teleomorphs or separately; either single, unilocular or multilocular, pycnidial conidiomata, or immersed to erumpent stromata bearing one to many lysigenous ostiolar canals. Walls of *textura globulosa*, *textura epidermoidea* to *textura angularis* toward the interior; conidiophores branched, simple or reduced to conidiogenous cells arising all around the locules. Conidiogenous cells phialides, sometimes proliferating percurrently, and invested in mucilaginous appendages. Anamorphs, when known, in either *Ceuthospora* or *Apostrasseria*.

Type genus: *Phacidium* Fr.
Lectotype species: *P. lacerum* Fr.:Fr.

Of the twenty-four genera placed in the Phacidiaceae by various authors, we retain only two, *Lophophacidium* and *Phacidium* (= *Phacidiostroma*).

KEY TO THE GENERA OF THE PHACIDIACEAE *sensu stricto*

1.1 Parasitic. Foliicolous. Ascomata marked by straw-coloured elliptical blisters, rupturing longitudinally; fungal covering of a central core of brown *textura globulosa*, pale brown *textura intricata* toward the interior and periphery, terminating with branched, septate, hyaline, smooth-walled periphysoids in mucilage. On leaves of *Picea* spp.
Anamorph unknown.....................................*Lophophacidium*. I.

1. *L. hyperboreum*

1.2 Parasitic or saprophytic. Foliicolous or caulicolous. Ascomata marked by brown to black, circular to subcircular swellings, ultimately rupturing in a stellate manner; fungal roof of dark brown *textura globulosa*, of vertically oriented pseudoparenchyma, terminating in simple, smooth-walled periphysoids invested in mucilage.
Anamorphs in either *Apostrasseria* or *Ceuthospora*......*Phacidium*. II.

1. *P. abietinum*
2. *P. abietis*
3. *P. aquifolii*
4. *P. arbuti*
5. *P. balsamicola*
6. *P. betulinum*
7. *P. cicatricola*
8. *P. coniferarum*
9. *P. dearnessii*
10. *P. eucalypti*
11. *P. gaeumannii*
12. *P. grande*
13. *P. heteromelis*
14. *P. infestans*
15. *P. lacerum*
16. *P. lunatum*
17. *P. multivalve*
18. *P. pini-cembrae*
19. *P. pusillum*
20. *P. salicinum*
21. *P. sherwoodiae*
22. *P. sphaeroideum*
23. *P. taxicola*
24. *P. vaccinii*
25. *P. vestergrenii*
26. *P. vincae*

DESCRIPTIONS OF THE GENERA AND SPECIES OF THE PHACIDIACEAE

I. Lophophacidium Lagerberg.

= Neonaumovia Schwarzman, (ut Neo-Naumovia).

Foliicolous. Ascomata usually hypophyllous, sometimes amphigenous, scattered to gregarious, often confluent, immersed, marked by circular patches of brown tissue, raised into straw-coloured, elliptical blisters, rupturing longitudinally; fungal covering layer composed of a central core of brown textura globulosa, pale brown textura intricata toward the interior and periphery, terminating with irregularly branched, septate, hyaline, smooth-walled periphysoids, often anastomosing, and invested in mucilage. Hymenium of asci and paraphyses. Asci club-shaped, apical ring dehiscence mechanism amyloid (I+). Ascospores fusiform to oblong-ellipsoid, straight or curved, subhyaline to hyaline, smooth-walled. Paraphyses abundant, simple or branched, septate, hyaline, smooth-walled, invested in mucilage.

Type species: Lophophacidium hyperboreum Lagerberg.

I.1 Lophophacidium hyperboreum Lagerberg — Figs. 147-153.

Svensk Bot. Tidskr. 43: 436 (1949).

= N. tianschanica Schwarzm., Bot. Mater. 12: 226 (1959).

Foliicolous. Ascomata usually hypophyllous, sometimes amphigenous, scattered to gregarious, 500-1000 X 250-400 µm, often confluent, running for several mm, initially immersed, intrahypodermal, marked by circular patches of brown pseudoparenchymatous cells forming a textura globulosa; raised into straw-coloured, elliptical blisters; host and fungal covering layer rupturing longitudinally; fungal roof composed of a central core of dark brown textura globulosa, grading to a pale brown textura intricata toward the interior and periphery, innermost layer of irregularly branched, septate, hyaline, smooth-walled periphysoids, up to 40 X 2.5-4 µm, often anastomosing and invested in copious mucilage. Hymenium of asci and paraphyses, up to 130 µm thick, pale yellow. Asci clavate, 8-spored, 85-125 X 12-15 ($\bar{x}$ = 105 X 13.5) µm, apical dehiscence ring amyloid (I+). Ascospores biseriate, fusiform to oblong-ellipsoid, non-septate, straight or slightly curved, often flattened on one side, guttulate, subhyaline to hyaline, smooth-walled, 15-23 X 6-8 ($\bar{x}$ = 19 X 7) µm, mean length/width ratio = 2.7:1. Paraphyses abundant, branched or simple, subcylindrical, septate, hyaline, smooth-walled, up to 130 X 2-2.5 µm, invested in mucilage.

Anamorph: unknown.

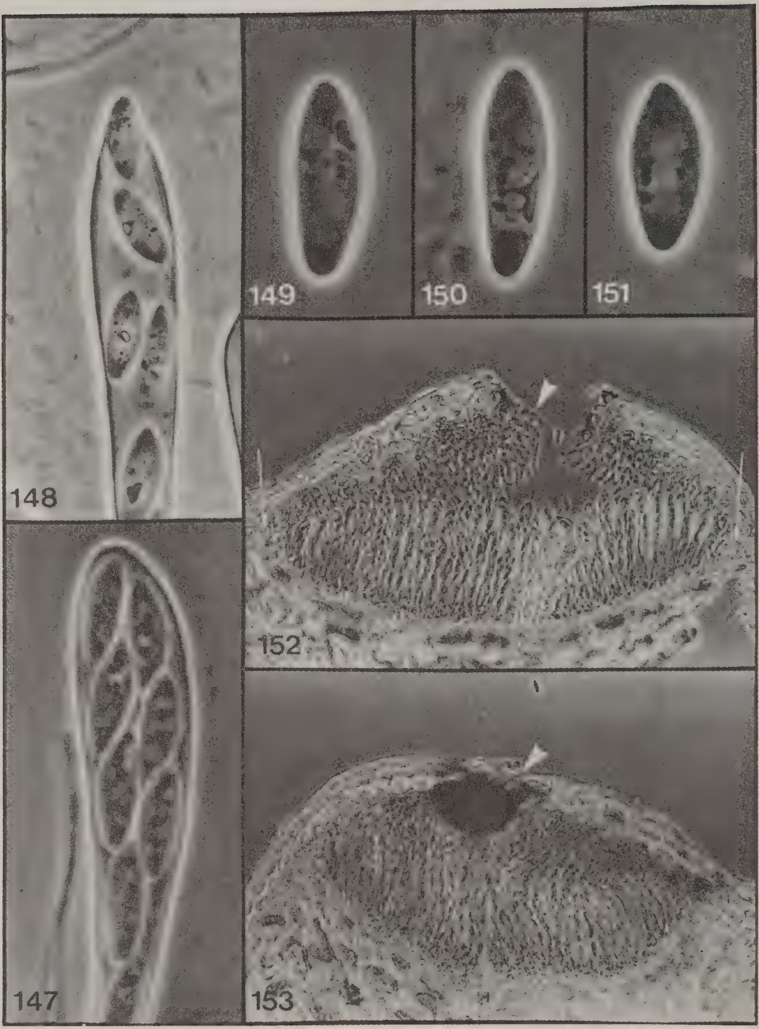
Habitat: on leaves of Picea abies, P. glauca, P. mariana, P. rubra and P. schrenkiana.

Known distribution: Canada; Sweden; Russia; U.S.A.

Specimens examined: In S, Holotype, B. Bergstrom, Sodra, Sweden; DAOM 325, Faull & McCallum, Claude L., Gaspe Co., Quebec, Canada, 1928-IX-11; DAOM-534, McCallum, Claude L., Gaspe Co., Quebec, Canada, 1928-IX-11; DAOM-1787, collection data as above; DAOM-1788, McCallum, L. Marsouin, Gaspe Co., Quebec, Canada, 1928-IX-12.

The damage done to Picea spp. by the 'spruce snow-blight' fungus has been known since 1910. Injuries to spruce leaves caused by the fungus in Sweden were reported in 1923, 1924, and 1935 (cited in Lagerberg 1949). In North America, Faull (1929, 1930) was the first to recognize the disease as 'Phacidium blight of conifers' in 1923. Faull (1929,1930) provided valuable information on the biology and control of the fungus.

However, it was Lagerberg (1949) who first recognized that the causal organism of 'spruce snow-blight' was not named. He introduced the genus Lophophacidium for the single species, L. hyperboreum, which he considered to be a member of the Phacidiaceae.



Lophophacidium hyperboreum. 147. Mature ascus. x 770. 148. Mature dehiscent ascus. x 770. 149-151. Mature ascospores x 1280. 152. V.S. mature, dehiscent ascoma: note that the dark, stromatic, central core has torn away (arrow-head). x 130. 153. V.S. ascoma central stromatic core *in situ* (arrow-head). x 130.

Schwarzman (1959) described Neonaumovia Schwarzm., based on N. tianschanica, found growing on Picea schrenkiana in Russia. Although we have not seen Schwarzman's fungus, his description and illustration leave no doubt in our minds as to the identity of N. tianschanica. We here consider N. tianschanica a synonym of L. hyperboreum. Korf (1962) in his synopsis of the Hemiphacidiaceae, was the first to recognize that the two fungi were identical.

Korf (1962) "...doubtfully referred..." L. hyperboreum to the Hemiphacidiaceae. However, Reid & Cain (1962) found that this fungus was better retained in the Phacidiaceae. We agree.

We retain L. hyperboreum in the Phacidiaceae on the basis of the fungal roof (Figs. 152, 153), the amyloid (I+) dehiscence mechanism of the ascus, and the subhyaline to hyaline ascospores (Figs. 149-151) that bear no mucilaginous sheaths.

Reid & Cain (1962) drew attention to what Faull (1930: 139) called "microsclerotia", and doubted the existence of these structures. Faull (1930) wrote that the 'snow-blight' fungus "...produced large numbers of tiny, black granules (microsclerotia) of compacted mycelium on the surfaces of blighted needles..." Reid & Cain never observed these structures. Perhaps Faull was referring to the dark, central core of textura globulosa (Fig. 153), (cf. Reid & Cain 1962: 486, Fig. 7). We have found, from studies of rehydrated herbarium material, that this central core of tissue is easily set free after it has served its apparent purpose of rupturing the host and fungal covering layer at maturity (Fig. 152). Only studies with fresh material can determine whether or not this stromatic tissue can disseminate L. hyperboreum.

Once this central core of textura globulosa has been liberated, the interior of the ascoma is exposed. The mucilaginous matrix covering the periphysoids imbibes water and swells. It is this swelling that raises the covering layer from the hymenium. The hyphae at the periphery of the ascoma remain intact, and function as 'hinges' (Fig. 152, arrows). Hoehnel (1917b) observed a similar mechanism in Phacidium lacerum.

The fungal covering layer in L. hyperboreum is different from that of Phacidium species. The hyphal elements of L. hyperboreum are not fused, except for the central core. However, during the course of evolution, a textura globulosa could easily be derived from a textura intricata immersed in mucilage.

II. *Phacidium* Fr. *nom. cons. prop.* Hawksworth & Sherwood, Taxon 30: 338-348 (1981).
non *Phacidium* Fr.:Fr.
= *Phacidiostroma* Hoehn. Annls. Mycol. 15: 325 (1917).
= *Gremmenia* Korf, *teste* Reid & Pirozynski, Mycologia 52: 526-531 (1960).

Lectotype species: *P. lacerum* Fr.:Fr.
Anamorphs: in *Apostrasseria* or *Ceuthospora*.

Caulicolous or foliicolous. Ascomata amphigenous, scattered to gregarious, initially immersed, subcuticular, subepidermal to subhypodermal, ultimately rupturing overlying host and fungal tissues by irregular stellate splits; fungal roof of vertical, short, cylindrical, dark brown outer pseudoparenchymatous cells forming a *textura globulosa*, pale brown toward the interior, innermost layer of periphysoids in mucilage. Hymenium of asci and paraphyses; subhymenium of *textura angularis* to *textura globulosa*; basal stroma present or absent; when present, of *textura globulosa*. Asci club-shaped, 4-8-spored, with an amyloid (I^+) apical dehiscence mechanism. Ascospores non-septate, ellipsoid, or irregularly ellipsoid to fusiform, uniseriate or biseriate, hyaline, smooth-walled. Paraphyses simple or branched, septate, often anastomosing, and invested in mucilage.

Often associated with anamorphs. Anamorphs, where known, in *Ceuthospora* or *Apostrasseria*.

Conidiomata pycnidial, immersed to erumpent, often appearing superficial, unilocular to multilocular, each locule with an ostiolar canal, brown, carbonous, glabrous to roughened; wall of dark brown to black outer pseudoparenchymatous cells in a *textura globulosa*, paler then hyaline toward the interior, in a *textura angularis*; *textura epidermoidea* toward the hymenium. Conidiophores branched or simple, septate, hyaline, smooth-walled, and invested in mucilage. Conidiogenous cells phialides which sometimes proliferate percurrently, subcylindrical, lageniform to ampulliform, hyaline, smooth-walled and invested in mucilage. Conidia blastic-phialidic, subcylindrical or ellipsoid, non-septate, hyaline, smooth-walled, with an irregular to funnel-shaped, apical, mucilaginous appendage.

Representative anamorph-genera: *Apostrasseria* and *Ceuthospora*.

SYNOPTIC KEY TO PHACIDIUM AND RELATED ANAMORPHS
(See Species List, p. 82)

Teleomorph

- I. Ascomata
  - I.1 Caulicolous, immersed in periderm: 6, 11, 12, 18, 19, 20, 23.
  - I.2 Foliicolous: 1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 21, 22, 24, 25, 26.
    - I.2.1 Subcuticular: 3, 5, 7, 9, 10, 12, 16, 19, 21, 25.
    - I.2.2 Intra- to sub-epidermal: 1, 2, 3, 4, 5, 6, 8, 9, 11, 12, 13, 14, 17, 18, 20, 22, 23, 24, 25, 26.
    - I.2.3 Intra- to sub-hypodermal: 1, 2, 14, 15.
    - I.2.4 Occupying entire leaf thickness: 16.

- II. Hymenium
  - II.1 KOH^{+}: 18.
  - II.2 KOH^{-}: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19, 20, 21, 22, 23, 24, 25, 26.
  - II.3 On a basal stroma: 3, 11, 16, 18, 19, 20, 22, 23, 24, 26.

- III. Asci:
  - III.1 4-spored: 12, 25.
  - III.2 8-spored: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 19, 20, 21, 22, 23, 24, 26.
  - III.3 Mean length 40-65 µm: 1, 3, 7, 19, 23, 24, 25, 26.
  - III.4 Mean length 65-90 µm: 6, 9, 10, 11, 12, 13, 16, 20, 21, 22.
  - III.5 Mean length greater than 90 µm: 2, 5, 8, 14, 16, 17, 18.
  - III.6 Mean width 5-10 µm: 1, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 15, 16, 18, 19, 20, 21, 23, 24, 25, 26.
  - III.7 Mean width greater than 10 µm: 2, 14, 17.

- IV. Ascospore arrangement:
  - IV.1 Biseriate: 1, 2, 4, 5, 7, 8, 9, 10, 11, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 26.
  - IV.2 Uniseriate: 3, 5, 6, 12, 16, 21, 24, 25.

- V. Ascospore shape:
  - V.1 Ellipsoid: 1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 15, 16, 19, 20, 21, 24, 25.
  - V.2 Subfusiform to fusiform: 4, 6, 7, 10, 11, 17, 21, 22, 23, 26.
  - V.3 Subreniform: 13.
  - V.4 Club-shaped to irregular: 18.

- VI. Ascospore dimensions:
  - VI.1 Mean length 6-12 µm: 1, 3, 4, 5, 6, 7, 8, 9, 11, 13, 15, 16, 19, 20, 21, 22, 24.
  - VI.2 Mean length 12.5-13 µm: 12, 26.
  - VI.3 Mean length 13-28 µm: 2, 10, 14, 17, 18, 22, 25.
  - VI.4 Mean width 2-3 µm: 1, 5, 7, 8, 13, 20, 21, 23, 26.
  - VI.5 Mean width 3-5 µm: 3, 4, 6, 9, 10, 11, 15, 16, 18, 19, 22, 23, 25.
  - VI.6 Mean width 5-8 µm: 2, 12, 14, 17.

- VII. Ascospore length/width ratio:
  - VII.1 Mean l/w ratio 2:1-3:1: 4, 7, 9, 12, 14, 16, 17, 23, 25.
  - VII.2 Mean l/w ratio 3:1-4:1: 1, 2, 3, 6, 10, 11, 15, 18, 19, 21, 22.
  - VII.3 Mean l/w ratio greater than 4:1: 5, 8, 13, 20, 24, 26.
- VIII. Anamorphs:
  - VIII.1 Anamorphs in Ceuthospora : 3, 5, 7, 8, 11, 13, 15, 16, 20, 21, 24, 26.
  - VIII.2 Anamorphs in Apostrasseria : 1, 4, 6, 9, 18, 19, 23.
- IX. Host substrate families:
  - IX.1 Apocynaceae: 26.
  - IX.2 Aquifoliaceae: 3, 16, 22.
  - IX.3 Betulaceae: 7, 20.
  - IX.4 Ericaceae: 4, 5, 12, 13, 21, 24, 25, 26.
  - IX.5 Leguminosiae: 26.
  - IX.6 Myrtaceae: 10.
  - IX.7 Pinaceae: 1, 2, 6, 8, 11, 14, 15, 17, 18.
  - IX.8 Rosaceae: 13, 19.
  - IX.9 Taxaceae: 9, 23.

Anamorph

- I. Anamorph-genera:
  - I.1 Anamorph in Ceuthospora: 3, 5, 7, 8, 11, 13, 15, 16, 20, 21, 24, 26.
  - I.2 Anamorph in Apostrasseria: 1, 4, 6, 9, 18, 19, 23.
- II. Conidiomata:
  - II.1 Caulicolous: 1, 6, 7, 9, 11,18, 19, 20.
  - II.2 Foliicolous: 1, 3, 4, 5, 7, 8, 9, 13, 16, 21, 23, 24, 26.
  - II.3 Single: 1, 4, 6, 9,15, 19, 23.
  - II.4 Grouped: 3, 5, 8, 13, 15, 16, 20, 21, 24, 26.
  - II.5 Stromatic: 1, 5, 6, 7, 8, 11, 13, 15, 16, 18, 20, 21, 24, 26.
  - II.6 Unilocular: 3, 5, 13, 15, 16, 20, 21, 23, 24, 26.
  - II.7 Multilocular: 1, 4, 6, 7, 8, 9, 11, 18, 19.
  - II.8 Immersed: 1, 3, 4, 5, 13, 15, 16, 19, 23, 26.
  - II.9 Erumpent: 7, 11, 15, 18, 20, 21, 24, 26.
  - II.10 Superficial: 11, 21.
- III. Conidiogenous cells:
  - III.1 Phialides with prominent collarettes: 3, 5, 7, 16, 20, 21, 23, 24.
  - III.2 Phialides with inconspicuous collarettes: 1, 4, 6, 8, 9, 11, 13, 15, 18, 19, 26.
- IV. Conidium shape:
  - IV.1 Subcylindrical: 3, 5, 7, 8, 11, 13, 15, 16, 20, 21, 24, 26.
  - IV.2 Ellipsoid: 1, 6, 9, 18, 23.
  - IV.3 Subreniform: 4, 9.
- V. Conidium appendages:
  - V.1 Funnel-shaped apical mucilaginous appendages: 3, 5, 7, 8, 11, 14, 15, 16, 20, 21, 24, 26.
  - V.2 Irregular apical mucilaginous appendages: 1, 4, 9, 18, 19, 23.

VI. Conidium dimensions:
VI.1 Mean length 5-9 µm: 1, 4, 6, 9, 11, 18, 19.
VI.2 Mean length 9-12 µm: 3, 7, 21, 23.
VI.3 Mean length 12-15 µm: 5, 8, 15, 16, 20, 24, 26.
VI.4 Mean length greater than 15 µm: 13.
VI.5 Mean width 2-3 µm: 1, 3, 4, 5, 6, 7, 8, 9, 11, 13, 15, 16, 18, 19, 20, 21, 24, 26.
VI.6 Mean width 3-4 µm: 23.

VII. Conidium mean length/width ratio:
VII.1 Mean length/width ratio less than 2:1: 18.
VII.2 Mean length/width ratio 2:1-3.1: 1, 4, 6, 9, 19, 23.
VII.3 Mean length/width ratio 3.1:1-4:1: 21.
VII.4 Mean length/width ratio 4.1:1-5:1: 3, 7, 11, 26.
VII.5 Mean length/width ratio 5.1:1-6:1: 5, 15, 16, 20, 24.
VII.6 Mean length/width ratio greater than 6:1: 8, 13.

VIII. Substrates:
VIII.1 Apocynaceae: 26.
VIII.2 Aquifoliaceae: 17, 22.
VIII.3 Betulaceae: 7,20.
VIII.4 Ericaceae: 4, 5, 12, 21.
VIII.5 Leguminosae: 26.
VIII.6 Pinaceae: 1, 6, 8, 12, 15, 16, 18, 21.
VIII.7 Rosaceae: 13, 19.
VIII.8 Taxaceae: 9, 23.

1. *Phacidium abietinum* Schm. Figs. 154-156.
in Kunze & Schm.:Fr., Syst. Mycol. 2: 577 (1823).
= *P. abietinum* Schm., in Kunze & Schm., Mycol. Hefte, 1: 35 (1817).

Anamorph: *Apostrasseria* sp.

Foliicolous. Ascomata amphigenous, scattered to gregarious, often crowded, usually discrete, up to 500-1000 µm diam., intrahypodermal, producing irregular swellings, then splitting the overlying fungal and host tissues. Fungal 'roof' of dark brown to brown outer pseudoparenchymatous cells forming a *textura globulosa*, 15-30 µm thick at the apex. Hymenium plane, pale yellow-grey, of asci and paraphyses, up to 62 µm thick; subhymenium of hyaline to pale yellow *textura angularis*, up to 25 µm thick. Asci clavate, tapering toward the flattened apex which has an amyloid (I^+) dehiscence ring, 44-62 X 6-8 ($\bar{x}$ = 52 X 7) µm. Ascospores biseriate, ellipsoid or irregularly ellipsoid to ellipsoid-fusiform, non-septate, guttulate, hyaline, smooth-walled, 9-14 X 2.5-4 ($\bar{x}$ = 11.5 X 3) µm, mean length/width ratio = 3.7:1. Paraphyses simple, septate, with rounded apices, smooth-walled, up to 60 X 1.5-2 µm, in mucilage.

Habitat: on leaves of *Abies alba*, *A. excelsa* and *A. pectinata*.

Known distribution: Europe.

Specimens examined: in FH, C. Roumeguère, Fungi Selecti Exs. no. 659, Reliquiae Libertinae, Malmedy; in S, J. Kunze, Fungi Selecti Exs. no. 377; Fungi helvetici no. 77, G. Winter, Utli, Zurich, IX-1878; ex herb. Sydow; G. Winter, Utli, Zurich, IX-1878; Krieger, Fungi saxonici no. 88, Koenigstein, W. Krieger, "Marz u Juli" 1885; ex herb. Rehm, Winter, 1878; F. Petrak, Mycotheca Generalis no. 283, Meisskirchen, F. Petrak, 1938-VIII; herb. Rehm, 1905-III; ex herb. Rehm no. 1039, G. Winter, Utli, Zurich, 1873-IX.

The unnamed anamorph of *P. abietinum* was noted by Brefeld (1891).

Apostrasseria anamorph of *Phacidium abietinum*. Figs. 157-162.

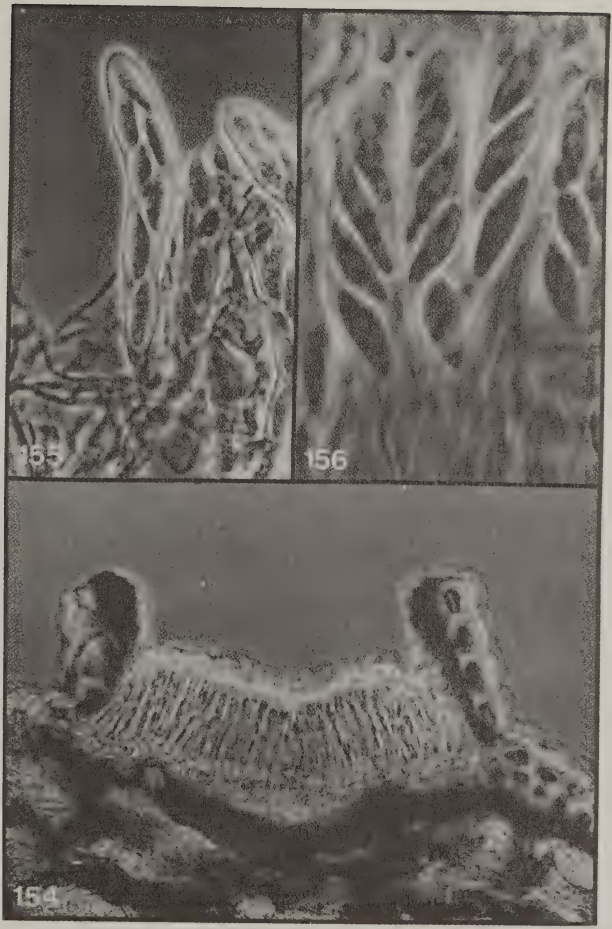
Foliicolous and caulicolous. Conidiomata scattered to gregarious; when on leaves, amphigenous, initially immersed, intrahypodermal, subglobose to depressed globose; when caulicolous, subcortical, pulvinate, up to 400 µm diam., of brown *textura globulosa* above, multilocular, locules separated by walls of pale brown *textura prismatica*, up to 15 µm thick, subhyaline toward the hymenium. Conidiogenous cells phialides, ampulliform, lageniform to subcylindrical, hyaline, smooth-walled, 4-6 X 2.4-4 ($\bar{x}$ = 5 X 3) µm, proliferating percurrently once or twice. Conidia blastic-phialidic, non-septate, guttulate, irregularly ellipsoid, base truncate, hyaline, smooth-walled, 6-7.5 X 2.5-3.5 ($\bar{x}$ = 7 X 3) µm, mean length/width ratio = 2.3:1, bearing anirregular, subapically inserted, mucilaginous appendage.

Habitat: on leaves and twigs of *Abies pectinata*.

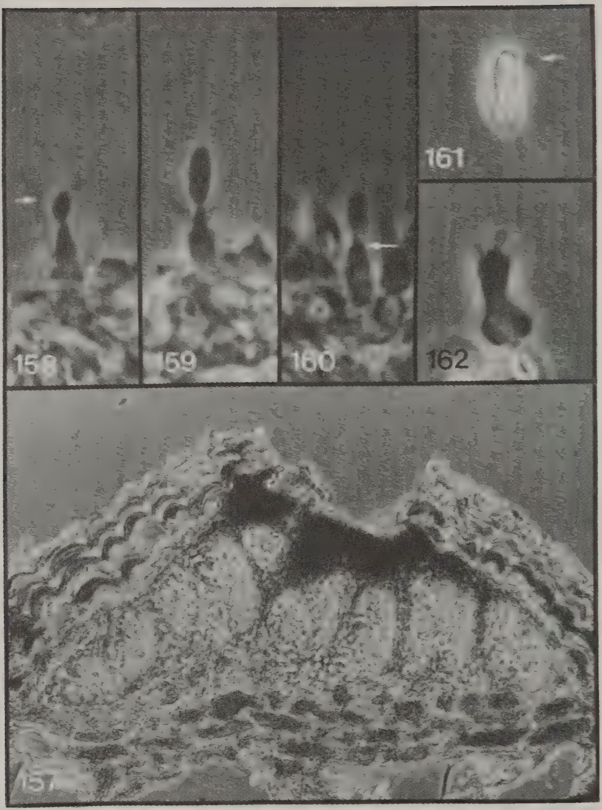
Known distribution: Europe.

Specimens examined: In S, J. Kunze, Fungi Selecti Exs. no. 377, IX-1878; ex herb. Sydow, G. Winter, Utli, Zurich, IX-1878.

Schmidt in Kunze & Schmidt (1817) introduced *P. abietinum* in the section 'Erumpentia' of *Phacidium*. Schmidt described macroscopic features, but failed to record microscopic details. Not surprisingly, he made no mention of the anamorph. Fries (1823) sanctioned the name, provided a very short description, and suggested that *P. abietinum* was closely related to *P. lacerum*. Saccardo (1889) accepted *P. abietinum* and provided an emended description, citing characters of asci, ascospores and paraphyses. He noted that the fungus occurred in England, France, Italy, Germany, Sweden and N. America. Saccardo found the 8-spored asci to be 40-45 X 8-10 µm. The oblong-fusoid, biguttulate, hyaline ascospores measured 9-11 X 3.5-4.5 µm.



Phacidium abietinum. 154. V.S. of mature ascoma. x 205. 155. Mature ascus and biseriate ascospores. x 770. 156. Detail of ascospores. x 1280.



Apostrasseria anam. of Phacidium abietinum. 157. V.S. of conidioma. x 205. 158. Conidigenous cell with a developing conidium, arrow indicates mucilage. 159, 160. Conidigenous cells and young conidia, arrow indicates collarette. x 1280. 161. Conidium, arrow indicates apical mucilaginous appendage. x 1280. 162. Conidiogenous cell with collarette. x 1280.

Following Fries (1823), Saccardo considered P. abietinum a close ally of P. lacerum.

Brefeld (1891) appears to have been the first to record an anamorph for P. abietinum in pure culture. He provided a detailed account of the teleomorph and anamorph, and found that the ellipsoid to ovoid, hyaline conidia measured 10-15 X 5 µm. Brefeld's illustrations of the anamorph of P. abietinum are remarkably reminiscent of those presented by Smerlis (1962) for Potebniamyces balsamicola Smerlis.

Rehm (1896) accepted P. abietinum in his Euphacidiales and provided a description. He also found that the ascus apical dehiscence mechanism was strongly iodine-positive (I^+) ("Jod blaut den schlauchporus stark"). Rehm believed that P. abietinum was closely related to P. lacerum, but had shorter asci and different ascospores.

We have been unable to locate any type or authentic material of P. abietinum. Figs. 157-162 are derived from J. Kunze, Fungi selecti exsiccati.

We found that the earlier descriptions of the teleomorph and anamorph were inadequate. Species with similar niches and spore characters were often confused. Only Brefeld (1891) illustrated the anamorph and attempted to bring together salient features of both teleomorph and anamorph. No single author has yet adequately described, illustrated, or discussed both phases now known to occur during the life cycle of P. abietinum. We have not demonstrated that the two morphs are genetically related using pure culture techniques. However, the circumstantial evidence is virtually indisputable in this case. We have found that several Phacidium spp. have Apostrasseria anamorphs. At least three of these have been studied in pure culture by various workers.

Wilson & Hahn (1928) introduced Phomopsis abietina (Hartig) Wils. & Hahn for a fungus pathogenic to Abies pectinata. From the descriptions and illustrations of Wilson & Hahn (1930) it is clear that Phomopsis abietina is related to the Apostrasseria anamorph of Phacidium abietinum: the two anamorphs appear congeneric. However, the dimensions cited by Hahn (1930) for Phomopsis abietina are much larger than those we cite for the Apostrasseria. Hahn noted that Phomopsis abietina had not been recorded outside of Germany. Our studies indicate that the Apostrasseria anamorph of Phacidium abietinum is restricted to Europe.

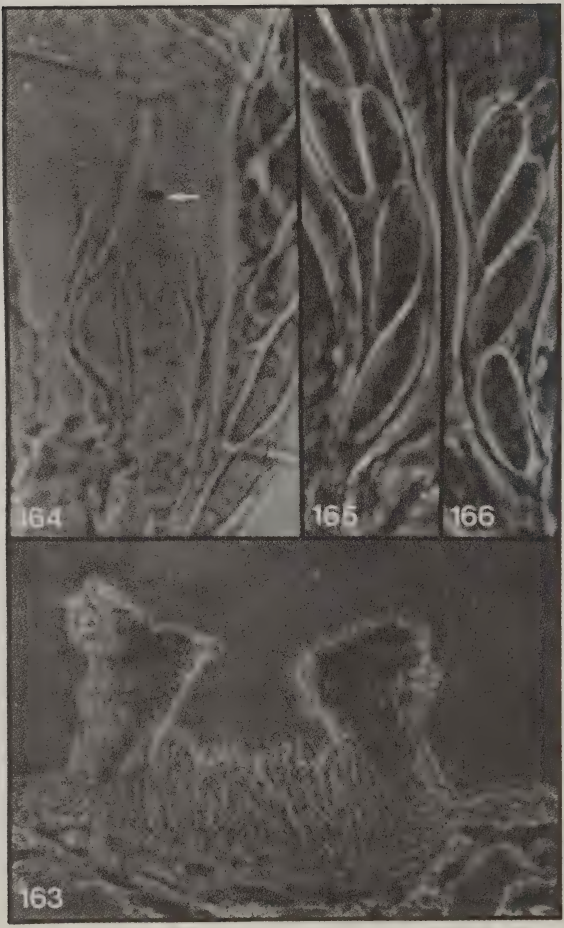
P. abietinum causes 'snow-blight' of Abies spp. in Europe. The infected leaves turn pale brown, remain on the branch, and ultimately die. The disease symptoms are remarkably similar to those caused by P. abietis Dearness, but P. abietis is easily distinguishable by its larger asci and ascospores.

P. abietinum has not yet been authentically (cf. Saccardo 1889) recorded in N. America, despite the fact that it is common in Europe and has a niche similar to that of P. abietis. We suggest that P. abietinum and P. abietis are very closely related, though geographically isolated.

Fries (1823) and Rehm (1896) suggested that P. abietinum was closely related to P. lacerum. Clearly, the two species are allied, but we do not think the relationship is 'close', because these species have different anamorphs. P. lacerum has Ceuthospora pinastri (Fr.) Hoehn. as its anamorph, and occurs on 2- and 3-needled Pinus spp. The anamorph of P. abietinum is best referred to Apostrasseria and occurs on Abies spp. and Pseudotsuga spp. P. abietinum is pathogenic to its hosts, while P. lacerum appears to be saprobic.

2. Phacidium abietis (Dearness) Reid & Cain Figs. 163-166.
Mycologia 54: 482 (1962).
≡ P. infestans Karsten var. abietis Dearness, Mycologia 18: 237 (1926).

Foliicolous. Ascomata hyphophyllous, usually on either side of the midrib, discrete, initially immersed, subepidermal to intrahypodermal,



Phacidium abietis. 163. V.S. of ascoma. x 125. 164. Detail of ascus apex, arrow indicates amyloid dehiscence ring. x 1280. 165, 166. Ascospores. x 1280.

ultimately erumpent, raising the overlying fungal and host tissues into dark brown or black swellings, 300-500 µm diam., which rupture stellately by 3-5 irregular teeth; the reflexed lobes of the overlying fungal tissue composed of dark brown to black outer pseudoparenchymatous cells forming textura globulosa which becomes less pigmented toward the interior, up to 100 µm thick above; innermost layer of hyaline, smooth-walled periphysoids which are immersed in mucilage. Hymenium pale yellow, up to 125 µm thick, of asci and paraphyses; subhymenium of hyaline textura angularis up to 25 µm thick; basal stroma of brown textura epidermoidea up to 25 µm thick. Asci club-shaped, 8-spored, flattened near the amyloid (I^+) dehiscence mechanism, 100-125 X 10-15 ($\bar{x}$ = 112 X 12) µm. Ascospores biseriate, ellipsoid-fusiform, curved, often flattened slightly to one side, tapered slightly below, guttulate, hyaline, smooth-walled, 17-23 X 5-6 ($\bar{x}$ = 20 X 6) µm, mean length/width ratio = 3.1:1. Paraphyses flexuous, simple or branched near the bases, septate, hyaline, smooth-walled, up to 125 X 1 µm, invested in mucilage.

Habitat: on leaves of Abies balsamea, A. concolor, A. grandis, A. lasiocarpa and Pseudotsuga menziesii.

Known distribution: Canada (Ontario); U.S.A. (California, Idaho, Oregon, Washington).

Specimens examined: In DAOM, Holotype, Dearness herbarium 5673 as P. infestans var. abietis, J. Weir, White Pine, Oregon, U.S.A., 1913-VI; in S ex TRTC 33548, R. F. Cain, Chamber Twp., Nipissing, Ontario, Canada, 1957-IX-19.

The anamorph of this species has not yet been discovered.

Weir (1916) provided field observations of P. infestans on western North American conifers. He reported that he had collections of P. infestans on A. concolor, A. grandis, A. lasiocarpa and Pseudotsuga taxifolia (= P. menziesii). Weir suggested that the fungus occurred between latitudes 40°N and 45°N, and noted that in Sweden, P. infestans rarely occurred below latitude 60°N.

Dearness (1926) considered the fungus on Abies spp., and Pseudotsuga taxifolia (= P. menziesii) to represent an undescribed variety which he named P. infestans var. abietis Dearness. Faull (1930) stated that different strains of P. infestans displayed host specificity and suggested that P. infestans var. abietis was a distinct species.

Reid & Cain (1962) raised the subspecific taxon to species level. Our observations are largely in agreement with theirs, although we found that the paraphyses were simple or branched and septate.

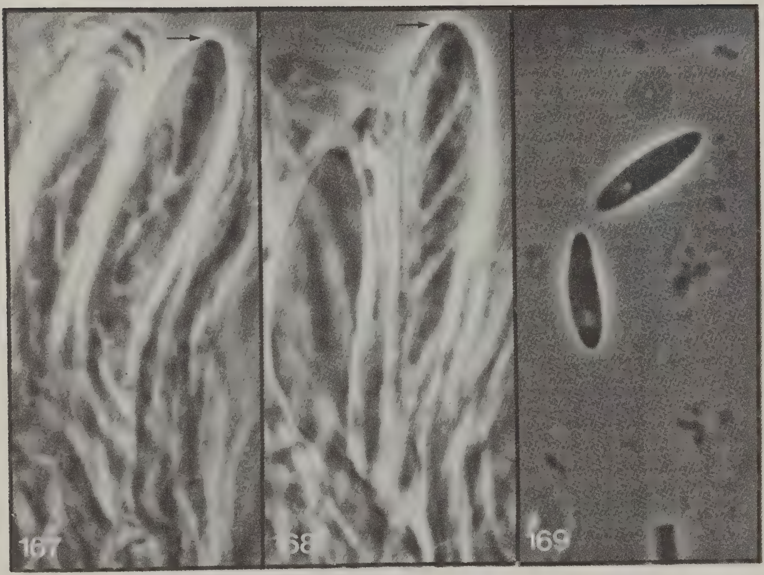
P. abietis is the causal agent of Phacidium 'snow-blight' of Abies spp. and Pseudotsuga menziesii in North America. Faull (1930) reported that the fungus also attacked Picea spp. and Pinus spp. Reid & Cain (1962) could not verify Faull's contention, because Faull based his identifications on the basis of host symptoms, and no mature ascomata were found on the Picea and Pinus collections.

Bega (1978) described the disease symptoms incited by P. abietis, which have sometimes reached epidemic proportions in Idaho and Oregon.

P. abietis is closely related to P. abietinum, but has larger asci and ascospores, and longer paraphyses.

Any 'natural' taxonomic scheme will represent a phylogeny, and as such will be predictive. No anamorph has yet been recorded for P. abietis. We suggest that when that anamorph is found, it will belong to Apostrasseria.

3. Phacidium aquifolii (DC.) Rehm — Figs. 167-169.
Kryptogamen-Flora p. 68 (1896).
≡ Xyloma aquifolii DC., Flor. France 5: 159 (1815).
≡ Phacidium aquifolii (DC.) Schm., in Kunze & Schm., Mycol. Hefte, p. 34 (1817).
≡ Phacidiostroma aquifolii (DC.) Hoehn., Annls. Mycol. 15: 325 (1917).



Phacidium aquifolii. 167, 168. Asci with amyloid apical dehiscence mechanisms (arrows). x 1280. 169. Two ascospores. x 1280.

= Sphaeria ilicis (Schleicher) Fr., *teste* Fries (Syst. Mycol. 2: 501 (1823)).

Foliicolous. Ascomata scattered to gregarious, sometimes confluent, oval to subcircular to rectangular in outline, black, 500-1500 µm diam., initially immersed, subcuticular to intraepidermal, raising the overlying fungal and host tissues into irregular swellings, ultimately splitting open irregularly by 3-5 teeth to expose the hymenium; overlying fungal tissue composed of dark brown *textura globulosa* which becomes brown toward the interior, up to 250 µm thick at the apex. Hymenium of asci and paraphyses, plane, pale yellow, up to 65 µm thick; subhymenium of pale yellow-brown *textura angularis* up to 12.5 µm thick, merging with a basal stroma of brown *textura globulosa* up to 20 µm thick. Asci club-shaped, 8-spored, flattened at the minutely papillate, amyloid (I^+) apex, 45-65 X 6-7.5 ($\bar{x}$ = 50 X 6.5) µm. Ascospores uniseriate, ellipsoid, straight or irregularly bent, guttulate, hyaline, smooth-walled, 9-12.5 X 2.5-3.5 ($\bar{x}$ = 11 X 3) µm, mean length/width ratio = 3.7:1. Paraphyses simple or branched, flexuous, septate, hyaline, smooth-walled, up to 65 X 1.5-2 µm, invested in mucilage.

Habitat: on leaves of *Ilex aquifolium*.

Known distribution: Europe.

Specimens examined: In G, Holotype ex herb. DeCandolle; in DAOM 89934, Mougeot & Nestler, Stirpes Crypt. Vogeso-Rhenanae Fasc. IV. no. 562 (1818); *ibid* in UPS.

Often associated with the teleomorph were conidiomata of a species of *Ceuthospora*. This may be the anamorph of *P. aquifolii*. The connection is strictly circumstantial, and requires confirmation. However, the connection and anamorph are described here in the hope of stimulating further studies.

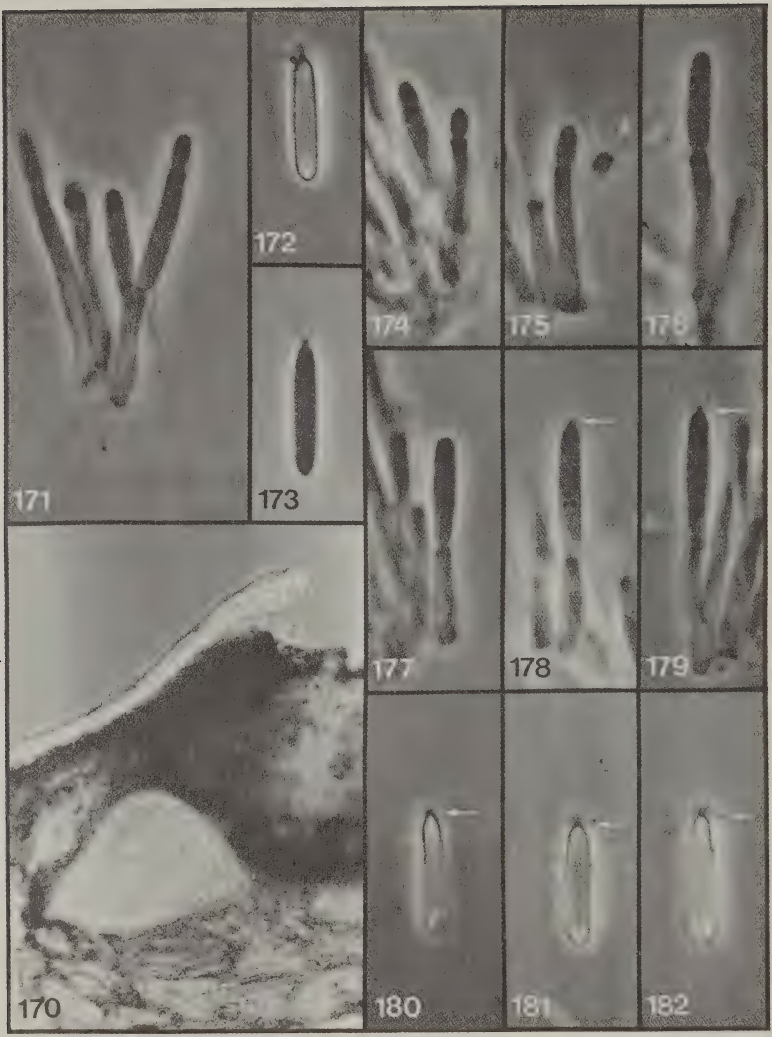
Presumed *Ceuthospora* anamorph of *P. aquifolii*. Figs. 170-182.

Foliicolous. Conidiomata pycnidial, amphigenous, scattered to gregarious, initially immersed, subepidermal, raising the overlying host tissue into irregular swellings, in groups of 3-5 individual pycnidia with necks up to 100 µm long, and ostioles with brown apices up to 30 µm diam., ultimately erumpent, sharing a mutual area of dehiscence which is bordered by brown *textura globulosa* and pale yellow to subhyaline furfuraceous cells; individual pycnidia globulose, subgloblose to depressed globose, 150-220 µm diam., wall of subhyaline *textura oblita* up to 15 µm thick. Conidiogenous cells phialides, arising all around the locules of the conidiomata from the innermost cells of the wall, subcylindrical, hyaline, smooth-walled, 5-15 X 2-2.5 ($\bar{x}$ = 10 X 2) µm, with minute, flaring collarettes, and invested in mucilage. Conidia blastic-phialidic, subcylindrical, tapered slightly toward the apex, bearing a minute dehiscence scar at the base, hyaline, smooth-walled, 11-14 X (2-) 2.5 ($\bar{x}$ = 12 X 2.5) µm, mean length/width ratio 4.8:1, enveloped in a mucilaginous sheath which becomes everted at maturity to form an irregular to funnel-shaped, apical mucilaginous appendage.

Specimens examined: in DAOM 89934, Mougeot & Nestler Stirpes Crypt. Vogeso-Rhenanae Fasc. IV, no. 562 (1818), as *Phacidium aquifolii*; *ibid* in S; in S. J. Ruegen, as *P. aquifolii*, (no other data).

DeCandolle (1815) introduced *Xyloma aquifolii* for a fungus on fallen, decaying leaves of *Ilex aquifolium*. Later (DeCandolle 1817), the teleomorph was redescribed and a habit illustration was provided. De Candolle's illustration was poor and the description inadequate. Schmidt, in Kunze & Schmidt (1817), transferred the species to *Phacidium* and provided an amended description. Schmidt considered *X. ilicis* Schleicher, (Pl. Crypt. Exs. Cent. 2, no. 84, *non X. ilicis* Fries (1815), referable to *P. aquifolii*, as indicated by his nomenclator.

Fries (1823) transferred *X. ilicis* Schleicher to *Sphaeria*, and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Presumed Ceuthospora anam. of Phacidium aquifolii. 170. V.S. portion of a conidioma. x 125. 171. Branched conidiophore. x 1280. 172. Conidium in dilute aqueous methylene blue. x 1280. 174-179. Sequence of conidium and appendage development. x 1280. 180-182. Sequence of appendage formation in dilute aqueous methylene blue. x 1280.

questioned Schmidt's transfer to Phacidium.

Rehm (1896) accepted P. aquifolii. He apparently did not study the type collection of X. aquifolii. His transfer to Phacidium was based on observations made on Moug. & Nestl., Stirp. Vog. 562.

Hoehnel (1917a) believed X. aquifolii belonged in Phacidiostroma.

Nannfeldt (1932) considered X. aquifolii identical with X. multivalve DC.

Arx & Mueller (1954) rejected Nannfeldt's suggestion and accepted the species as P. aquifolii (DC.) Schm. In the opinion of these authors, X. aquifolii had larger ascospores than X. multivalve. Rehm (1896) had earlier made a similar observation.

We have examined the holotype of X. aquifolii housed in G., and Moug. & Nestl. Stirp. Vog. 562 in DAOM and UPS, and found a teleomorph referable to P. aquifolii in association with a Ceuthospora anamorph.

The ascoma of P. aquifolii does not occupy the entire leaf thickness. The asci (45-65 X 6-7.5 µm) are smaller, and the ascospores (9-12.5 X 2.5-3.5 µm) are slightly larger than those of P. multivalve, which also occurs on Ilex aquifolium. Rehm (1896) found the asci to be 75-90 X 18-20 µm, and the spores 17-20 X 6-8 µm. We could not confirm these dimensions.

The associated anamorph is reminiscent of Ceuthospora foliicola (Lib.) Jaap. However, the conidiomata of the Ceuthospora anamorph of P. aquifolii are more stromatic than those of C. foliicola. The conidia of C. foliicola have a slightly narrower size range (10.5-13 X 2.5 µm) than those of the anamorph of P. aquifolii (11-14 X 2-2.5 µm). Such minor variations in conidial dimensions assume new significance when the teleomorphs are considered.

We recognize the similarity between P. aquifolii and P. vincae (q.v.). When more adequate collections of P. aquifolii are examined, it may be necessary to unite these species. We have judged it appropriate to maintain both species for the present.

4. Phacidium arbuti Cooke & Harkness Fig. 183.

Grevillea 14: 10 (1885).

Foliicolous. Ascomata hypophyllous, scattered to gregarious, often confluent, circular to irregular in outline, up to 650 µm long and up to 400 µm wide, subcuticular to intraepidermal, raising the overlying host tissue into pulvinate swellings, then splitting the overlying fungal tissue into 3-6 irregular teeth, exposing the hymenium; covering layer of brown textura globulosa which is paler toward the hymenium; innermost layer is of hyaline periphysoids. Hymenium plane, pale yellow-brown, up to 130 µm thick, of asci and paraphyses; subhymenium hyaline, of textura angularis up to 20 µm thick, subhyaline to pale yellow toward the basal stroma; basal stroma of textura epidermoidea up to 20 µm thick. Asci club-shaped, 8-spored, 69-130 X 7.5-9 ($\bar{x}$ = 100 X 8) µm, with an amyloid (I^+) apical dehiscence mechanism. Ascospores usually uniseriate, but sometimes biseriate in apical region of ascus, oblong-ellipsoid, 10.5-14 X 2.5-4 ($\bar{x}$ = 12.5 X 3) µm, mean length/width ratio = 4.2:1. Paraphyses usually simple, sparsely septate, apices slightly swollen and rounded, up to 130 X 2-2.5 µm, invested in mucilage.

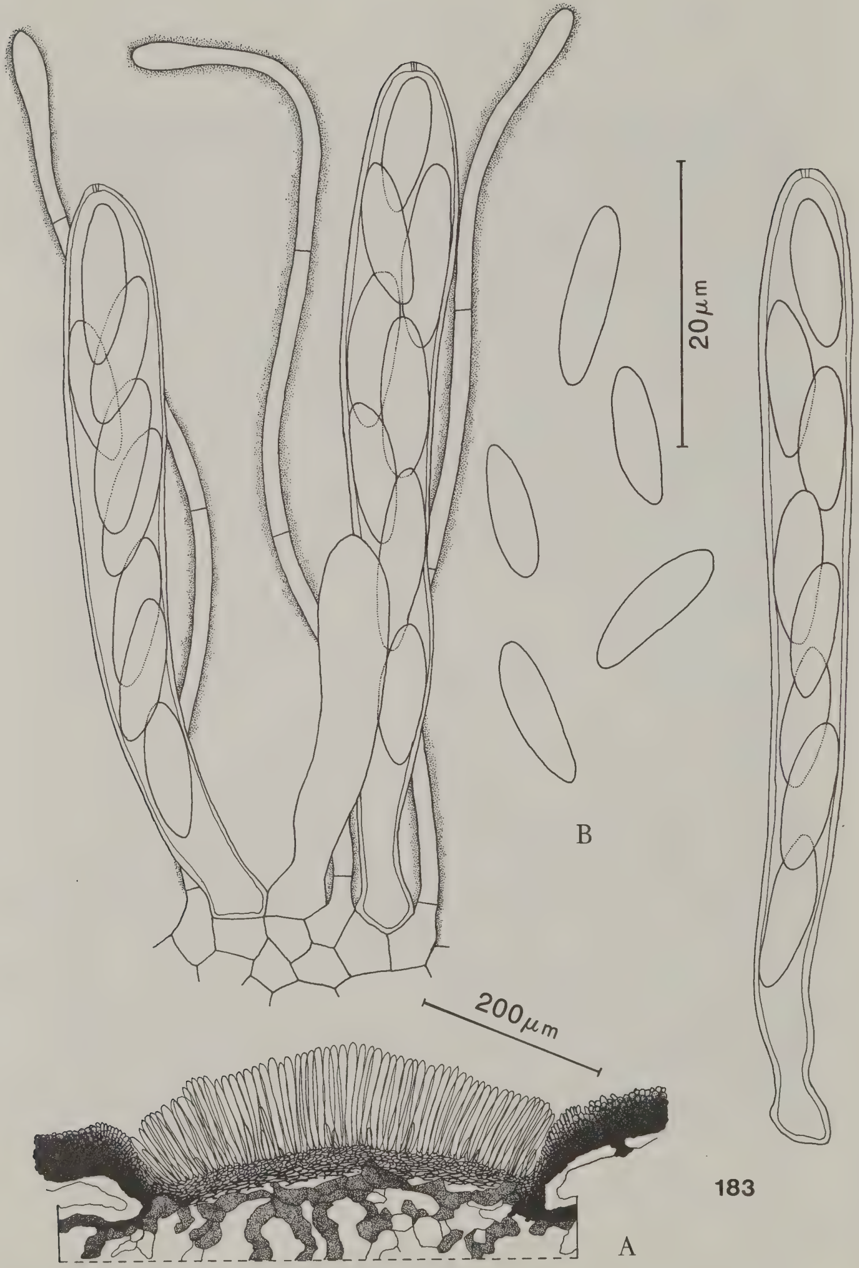
Habitat: on leaves of Arbutus menziesii.

Known distribution: U.S.A. (California). Specimen examined: In BPI, Holotype, Harkness no. 2122, H.W. Harkness, Mt. Tamalpais, Madera, Calif., U.S.A., 1881-II.

On the type material of P. arbuti a Ceuthospora species, tentatively considered the anamorph of P. arbuti, was found.

Ceuthospora anamorph of Phacidium arbuti. Figs. 184-189.

Foliicolous. Conidiomata pycnidial, amphigenous, abundant, scattered to


20μm
B
200μm
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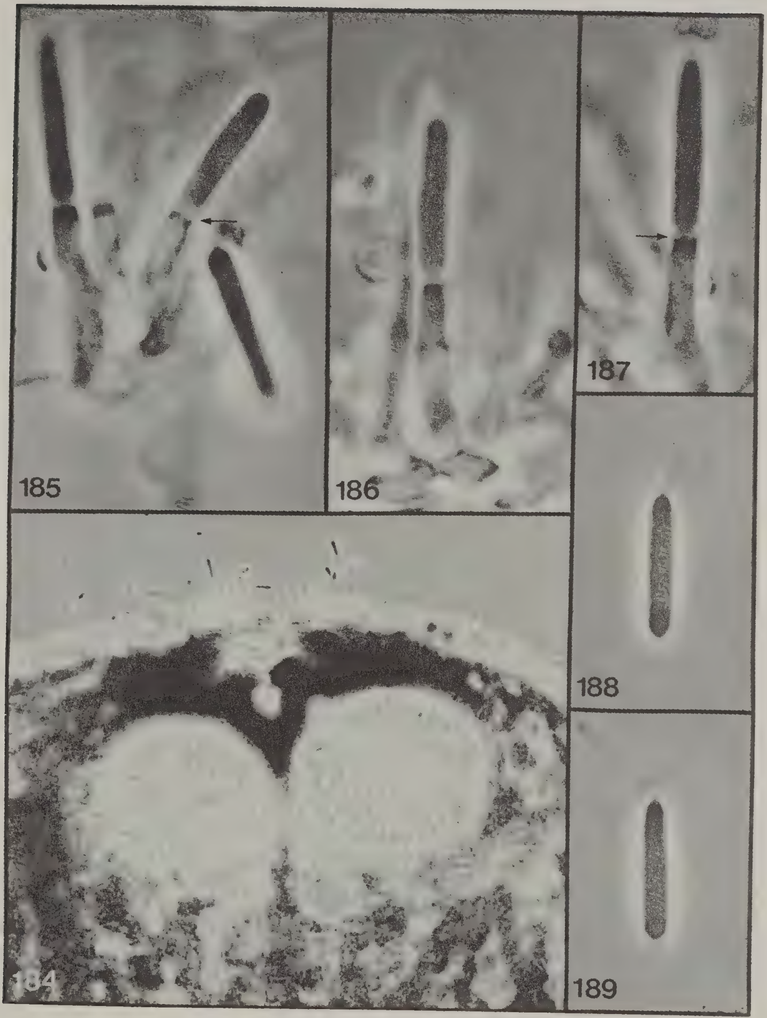
A

Phacidium arbuti. 183. A. V.S. of mature ascoma. B. Asci, ascospores and paraphyses.



Ceuthospora anamorph of *Phacidium arbuti*. 184. V.S. of conidioma. x 205. 185-187. Conidiogenous cells and developing conidia, arrows indicate collarettes. x 1280. 188, 189. Mature conidia, with funnel-shaped, apical, mucilaginous appendages. x 1280.

gregarious, at first immersed, subepidermal, ultimately erumpent, globose to subglobose, unilocular, glabrous, subhyaline to pale yellow below, up to 130 µm diam., and up to 170 µm high, ostiolate, ostioles sharing a mutual area of dehiscence which is marked by brown *textura globulosa*; wall of subhyaline to pale yellow *textura prismatica*, hyaline toward the hymenium. Conidiophores arising from the innermost hyaline cells of the conidioma, all around the locule, branched, septate, often reduced to simple, subcylindrical conidiogenous cells. Conidiogenous cells phialides, hyaline, smooth-walled, 7.4-14 X 2-2.5 ($\bar{x}$ = 10.5 X 2.5) µm, bearing a minute flaring collarette and invested in mucilage. Conidia subcylindrical, unicellular, straight, bases rounded, often bearing a minute basal dehiscence scar, tapered toward the apex, hyaline, smooth-walled, 14-16 X 2-2.5 ($\bar{x}$ = 15 X 2.5) µm, mean length/width ratio = 6:1, invested in a partial mucilaginous sheath that everts at maturity to form a funnel-shaped apical appendage.

P. arbuti is most similar to *P. heteromelis* Phill. & Harkn., but has longer asci and wider ascospores. The presumptive *Ceuthospora* anamorph of *P. arbuti* produces conidia from non-proliferating phialides with conspicuous collarettes (Figs. 185-187, arrows). The conidiogenous cells of the *Ceuthospora* anamorph of *P. heteromelis* proliferate percurrently (Fig. 290). The conidia of *P. heteromelis* are also larger than those of *P. arbuti*.

5. *Phacidium balsamicola* (Smerlis) DiCosmo, Nag Raj& Kendrick
Figs. 190-195.
Can. J. Botany 61(1): 31-44 (1983).
≡ *Potebniamyces balsamicola* Smerlis, Can. J. Botany 40: 352-353 (1962).

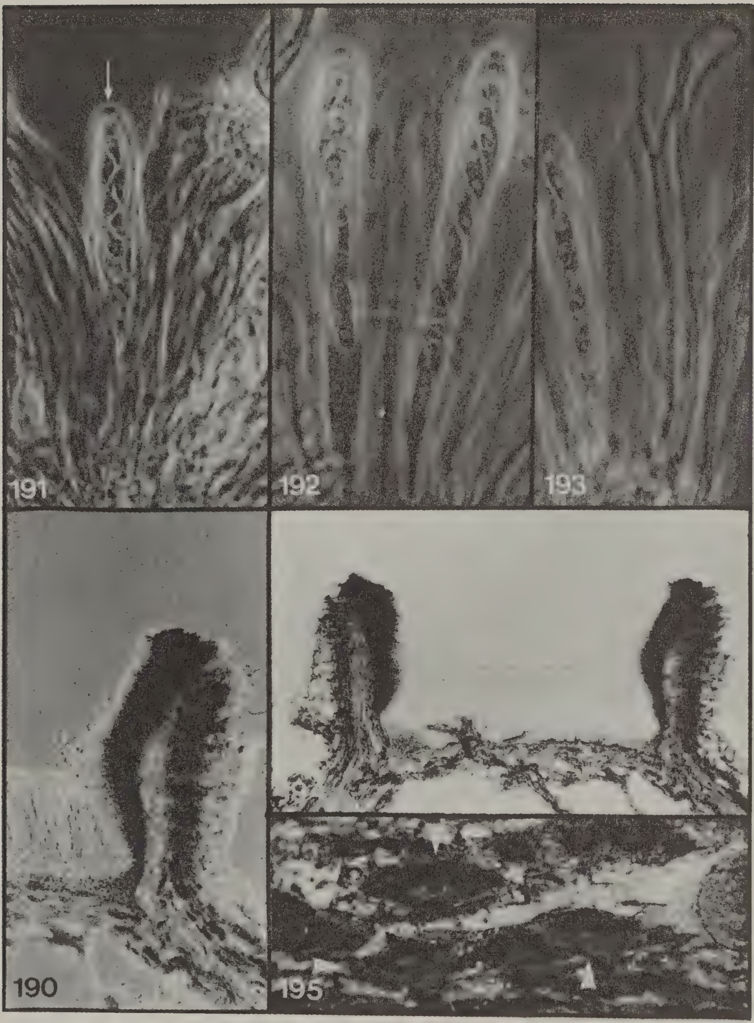
Caulicolous. Ascomata scattered to gregarious to densely crowded and confluent, circular to irregular in outline, darker than the surrounding host tissue, black when dry, initially immersed, subepidermal, raising the overlying host and fungal tissues into irregular swellings, ultimately splitting open irregularly by teeth to expose the hymenium, 500-1500 X 500-1000 µm, hymenium remaining immersed, raised portion consisting of reflexed lobes of fungal and host layers; fungal roof consisting of brown to dark brown pseudoparenchymatous cells forming a *textura globulosa*, becoming paler toward the interior, up to 65 µm thick above, 10 µm thick below, the inner surface lined with simple or branched, septate, hyaline, smooth-walled periphysoids, 10-20 X 2-3 µm, with rounded apices and invested in mucilage. Hymenium plane, up to 90 µm thick, smoke-grey; subhymenium of *textura angularis*, hyaline, pale yellow-brown away from the hymenium, up to 25 µm thick; basal stroma of pale brown *textura epidermoidea* up to 15 µm thick. Asci club-shaped, 8-spored, 65-90 X 5-8 ($\bar{x}$ = 82 X 6.5) µm, with amyloid (I^{+}) apical dehiscence ring. Ascospores usually uniseriate, ellipsoid-fusiform, guttulate, hyaline, smooth-walled, 8-15 X 2.5-4 ($\bar{x}$ = 11 X 3.5) µm, mean length/width ratio = 3.1:1. Paraphyses subcylindrical, simple or branched, septate, hyaline, smooth-walled, up to 92 X 1.5-2 µm, apices rounded, invested in mucilage.

Habitat: on branches and twigs of *Abies balsamea*, *A. lasiocarpa*.

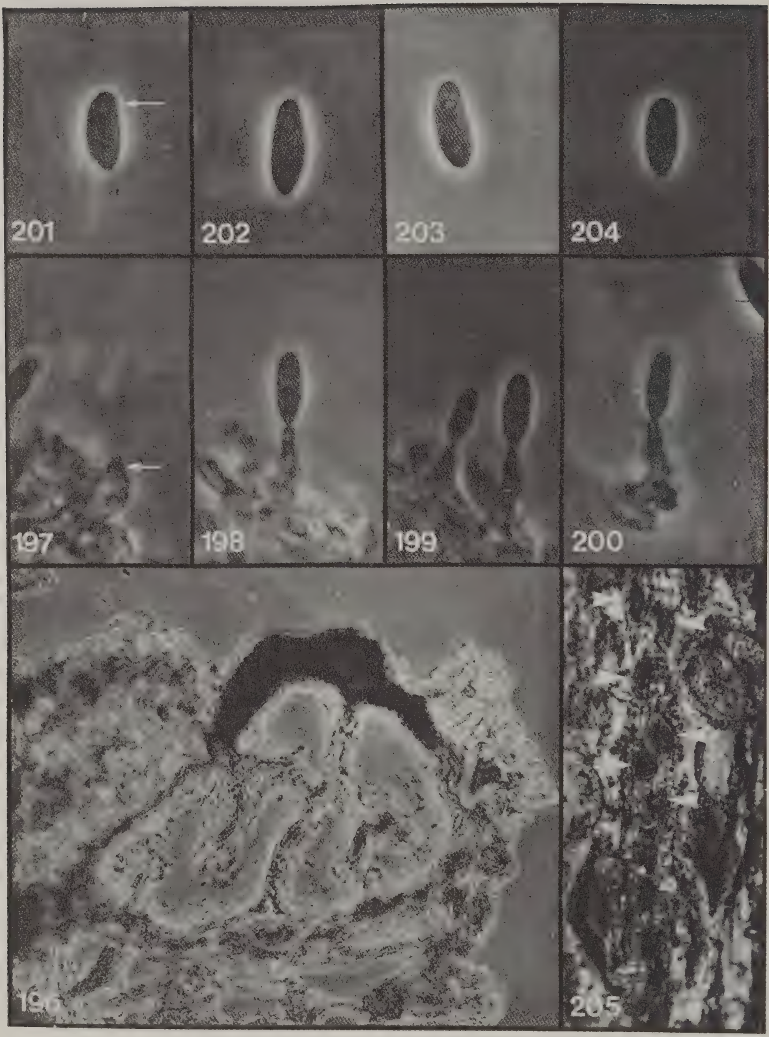
Known distribution: Canada (British Columbia, New Brunswick, Quebec); U.S.A. (Idaho).

Specimen examined: in DAOM, Holotype, 89326 ex HPFQ 18122, E. Smerlis, St. Tite des Caps, Charlevoix, Quebec, 1959-IX-15.

Smerlis (1962) studied the unnamed anamorph of *Potebniamyces balsamicola* in pure culture. Funk (1970) named this anamorph *Phacidiopycnis balsamicola* Funk. Examination of type material shows that it is better disposed in *Apostrasseria*.



Phacidium balsamicola. 190. V.S. part of mature ascoma, showing details of margin. x 125. 191. Mature ascus, arrow shows amyloid dehiscence mechanism. x 770. 192. Two mature asci containing ascospores. x 130. 193. Branched paraphysis invested in mucilage. x 770. 194. V.S. of ascoma. x 8. 195. Habit, arrow-heads indicate erumpent ascomata. x 6.5.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Apostrasseria balsamicola anam. of *Phacidium balsamicola*. 196. V.S. of multiloculate conidioma. x 205. 197-200. Conidiogenous cells, with conidia at various stages of development. x 1280. 201-204. Conidia, arrow indicates the subapical dimple. x 1280. 205. Habit of conidiomata (arrow-heads). x 6.5.

Apostrasseria balsamicola (Funk) DiCosmo, Nag Raj & Kendrick, comb. nov.
Figs. 196-205.
≡ *Phacidiopycnis balsamicola* Funk, Can. J. Botany 40: 352 (1962).

Caulicolous. Conidiomata pycnidial, scattered, gregarious to crowded, immersed, subepidermal, raising the overlying host tissue into irregular to subconical swellings, which ultimately rupture to reveal the black, carbonous apical area of the conidioma; subglobose to depressed-globose, multiloculate, dark brown to brown above, ostiolate, 200-350 µm diam., 200-300 µm tall; upper wall of *textura globulosa* up to 50 µm thick; toward the base, thin-walled, pale yellow to subhyaline, up to 10 µm thick; inner walls 10-20 µm thick, pale yellow-brown, hyaline toward the hymenium. Conidiogenous cells phialides, completely lining the locules, subcylindrical, lageniform to ampulliform, proliferating percurrently 1-3 times, discrete, 4-10 X 2.5-4.5 ($\bar{x}$ = 6 X 3) µm, invested in mucilage. Conidia blastic-phialidic, irregularly ellipsoid to oblong, biguttulate, rounded above with a subapical dimple, base tapering and truncate, hyaline, smooth-walled, 6-9 X 2.5-3 ($\bar{x}$ = 7 X 2.5) µm, mean length/width ratio = 2.8:1.

The taxonomic and nomenclatural histories of *Potebniamyces* Smerlis (1962) have already been presented, and the type species, *P. pyri*, is illustrated in Figs. 97-104.

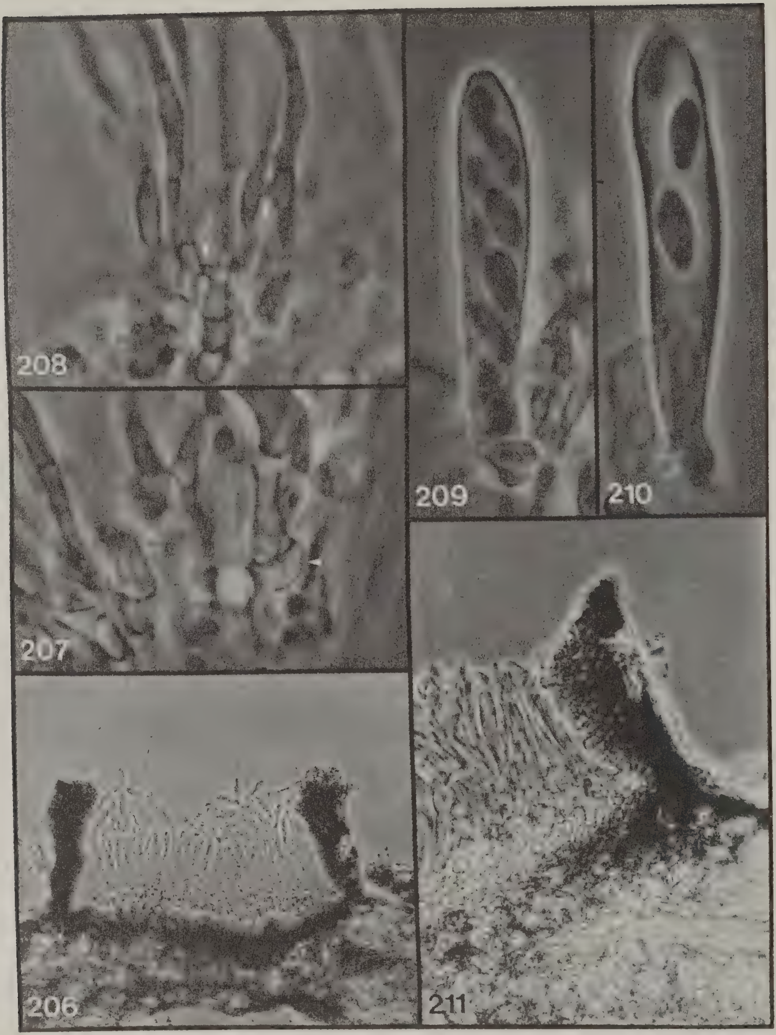
Smerlis (1962) introduced *Potebniamyces balsamicola* with an illustrated account. He used mass ascospore and mass conidial inoculations to show that *P. balsamicola* had a *Phomopsis*-like anamorph, but did not formally name it. Conidiomata were readily produced in pure culture.

Funk (1969) found that *P. balsamicola* was associated with a die-back and canker disease of *Abies lasiocarpa* (Hook) Nutt. Funk (1970) introduced *P. balsamicola* var. *boycei* Funk and its anamorph *Phacidiopycnis boycei* (Hahn) Funk. He found that *Potebniamyces balsamicola* var. *boycei* differed from *Potebniamyces balsamicola* var. *balsamicola* only in morphology of the anamorph. *Phacidiopycnis boycei* bore characteristic, irregularly-triangular to trapezoid, rarely ellipsoid, conidia. Funk (1970) proved the genetic connection between *Potebniamyces balsamicola* var. *boycei* and its anamorph using mass ascospore and mass conidium inoculations.

Potebniamyces balsamicola var. *balsamicola* superficially resembles *P. pyri* (the type species of *Potebniamyces*), but differs in many important characteristics. Microanatomical studies have indicated that the margin of *P. pyri* is a complex structure, of *textura globulosa* and simple to branched periphysoids invested in mucilage (Figs. 97, 104). The ascus apex of *P. pyri* is relatively thin-walled, dehiscence is by irregular apical rupture, and no structured dehiscence mechanism was discernible (Fig. 101).

Potebniamyces balsamicola var. *balsamicola* is similar to *P. piri* in being caulicolous, but here the similarity ends. The margin of *P. balsamicola* var. *balsamicola* (Figs. 190, 194) is less complex than that of *P. pyri*. The ascus apex of *P. balsamicola* var. *balsamicola* (Fig. 191) is pierced by an amyloid (I^+) dehiscence ring. The *Apostrasseria* anamorph of *P. balsamicola* var. *balsamicola* does not appear to be closely related to *Phacidiopycnis piri*, the anamorph of *Potebniamyces pyri*. The *Apostrasseria* anamorph provides a link with species of *Phacidium*. Indeed, it is quite clear from this study that *Potebniamyces balsamicola* var. *balsamicola* is best disposed in *Phacidium*.

6. *Phacidium betulinum* Mouton Figs. 206-211.
Bull. Soc. Roy. Bot. Belgium 39: 50 (1900).



Phacidium betulinum. 206. V.S. of mature ascoma. x 125. 207. Detail of proliferating crozier, arrow-head indicates crozier. x 1280. 208. Detail of anastomoses between adjacent paraphyses: arrow-heads indicate septate hyphal bridges. x 1280. 209, 210. Two mature asci. x 1280. 211. Detail of margin of mature ascoma. x 190.

Foliicolous. Ascomata hypophyllous, rarely epiphyllous, scattered to gregarious, often confluent, subcircular to irregular in outline, up to 500 µm diam., usually subcuticular, raising the overlying host and fungus tissues into subconical to orbicular swellings, then splitting the overlying fungal tissue into 4-5 irregular teeth, composed of brown, outer pseudoparenchymatous cells forming a textura globulosa up to 50 µm thick above, paler toward the interior; innermost cells subhyaline, smooth-walled periphysoids invested in mucilage. Hymenium plane, of asci and paraphyses, up to 62.5 µm thick; subhymenium of closely compacted, septate hyphae, forming a hyaline textura epidermoidea 10-15 µm thick; basal stroma of brown textura epidermoidea 20-25 µm thick. Asci club-shaped, 8-spored, flattened slightly toward the amyloid (I^+) apical dehiscence mechanism, 50-62 X 5-8 ($\bar{x}$ = 56 X 7) µm. Ascospores biseriate, irregularly ellipsoid to subfusiform, straight or slightly curved, 7.5-10 X 2.5-3.5 ($\bar{x}$ = 8.5 X 3) µm, mean length/width ratio = 2.8:1. Paraphyses simple or branched, septate, hyaline, smooth-walled, up to 60 X 1.5-2 µm diam., frequently anastomosing, invested in mucilage.

Habitat: on fallen leaves of Betula alba.

Known distribution: Belgium; Finland.

Specimen examined: In H, Holotype of Ceuthospora coronata, P. A. Karsten, no. 1586, Tavastia, Tammela, Mustiala, Finland, 1869-V-08.

Mouton (1900) found conidiomata intimately associated with the teleomorph of P. betulinum but did not name the anamorph, which had, however, been described independently by Fuckel (1869) and Karsten (1884).

Ceuthospora subcorticalis Fuckel Figs. 212-216.
Jahrb. Nass. Natur. 23/24: 398 (1869/1870).
= C. coronata (Karst.) Hoehn., Mitt. Bot. Inst. Techn. Hochsch. Wien 2: 102-103 (1925).
≡ Fusicoccum coronatum Karsten, Hedwigia 23: 21 (1884).

Foliicolous or corticolous. Conidiomata pycnidial, usually hypophyllous, rarely epiphyllous, scattered to gregarious, initially immersed, raising the overlying host tissue into orbicular swellings up to 200-350 µm diam., ultimately rupturing the overlying tissue to expose an area of dehiscence bordered by subhyaline to pale yellow furfuraceous cells; black, multilocular, 2-5 irregular locules, 100-150 µm tall with individual ostioles; outer wall of dark brown textura globulosa, giving rise to textura epidermoidea toward the interior, 20-40 µm thick, ultimately becoming subhyaline to hyaline textura oblita, 20-40 µm thick. Conidiophores completely lining the locules, arising from the innermost hyaline cells, simple or branched, septate, hyaline, smooth-walled, 5-10 X 2-2.5 ($\bar{x}$ = 7 X 2.5) µm, invested in mucilage. Conidiogenous cells phialides, subcylindrical, slightly tapered above, hyaline, smooth-walled, 10.5-14 X 2-2.5 ($\bar{x}$ = 12 X 2.5) µm, mean length/width ratio = 4.8:1, invested in a partial mucilaginous sheath, which becomes everted at maturity to form an apical, irregular to funnel-shaped mucilaginous appendage.

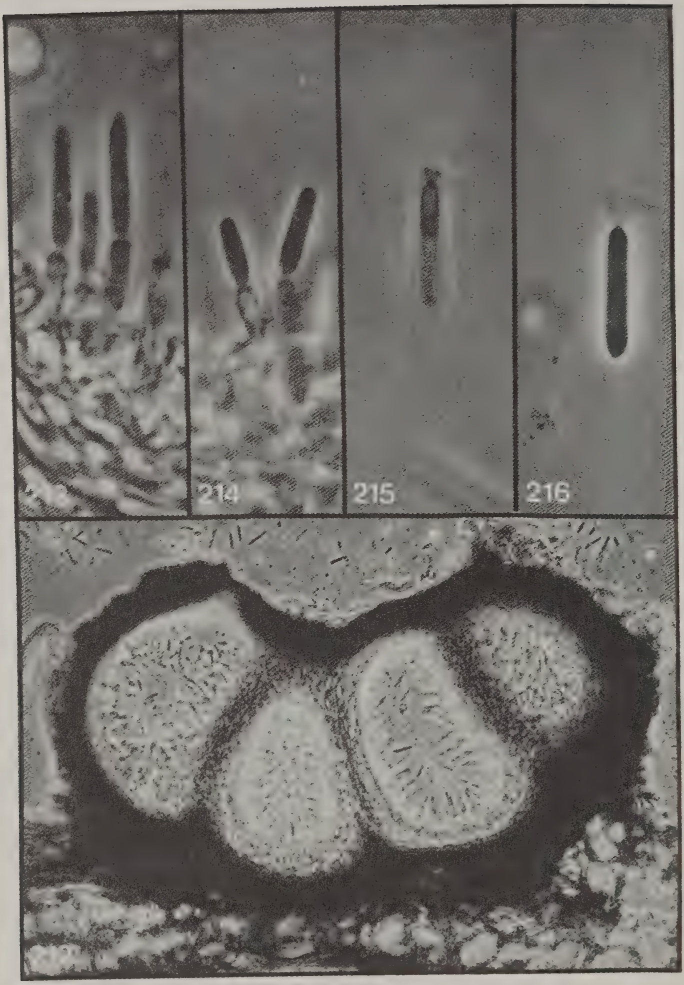
Habitat: on fallen leaves and inner surface of bark of Betula alba.

Known distribution: Austria; Belgium; Finland.

Specimens examined: In NY, Isotype of C. subcorticalis Fuckel, Fungi Rhenani 640 ex Herbier Barbey-Boissier 2254, L. Fuckel, Austria; in H, Holotype of C. coronata, P. A. Karsten no. 1586, Finland, 1869-V-08.

We have not been able to study the type material of P. betulinum, but Mouton's description and illustrations leave no doubt as to the identity of the species. Our observations of the teleomorph support some of Mouton's, and his measurements of asci, ascospores and conidia fall well within the range we report.

Fuckel (1869/1870) described C. subcorticalis Fuckel, but was unaware of its teleomorph. He reported the conidia as 2-3-septate. This is an error,



Ceuthospora subcorticalis anam. of *Phacidium betulinum*. 212. V.S. of multiloculate conidioma. x 205. 213. Detail of hymenium showing subhymenium and phialidic conidiogenesis. x 190. 214. Conidiogenous cells and conidia. x 1280. 215. Conidium with apical appendage in process of eversion. x 1280. 216. Conidium with fully everted mucilaginous appendage. x 1280.

because we have examined a portion of Fuckel's material and found only non-septate conidia. Karsten (1884) introduced *Fusicoccum coronatum* Karst., and later, (Karsten 1890) suggested that *F. coronatum* might well be the anamorph of *Coccomyces coronatus* (Fr.) Karst.

Hoehnel (1925) transferred *F. coronatum* to *Ceuthospora*. He believed *Coccomyces coronatus* (Schuem.):Fr. to be the teleomorph of *Ceuthospora coronata* (Karst.) Hoehn.

Although Karsten (1884) and Hoehnel (1925) referred the teleomorph to *Coccomyces coronatus*, probably on the basis of its host preference, we doubt if either author actually studied *C. coronatus* or knew what species that name represented. Our studies indicate that the teleomorph noted by both Karsten and Hoehnel is *Phacidium betulinum*.

The development of *P. betulinum* is typically phacidiaceous. The asci arise from croziers, but each crozier does not necessarily give rise to an ascus (Fig. 207). The paraphyses arise from the subhymenium, are septate, and neighbouring paraphyses frequently produce hyphal bridges (Fig. 208) that ultimately develop a median septum.

The *C. subcorticalis* anamorph of *P. betulinum* is as conspicuous as the teleomorph, and is often the commoner of the two morphs. Yet *C. subcorticalis* is poorly known. Prior to the present study, the anatomy and conidiogenesis of this species were unknown. An illustrated account (Figs. 212-216) is presented here.

Both teleomorph and anamorph are saprobic. The fungus is common in Europe, and can be found in the leaf litter layer of the forest floor. *P. betulinum* is one of the two species of *Phacidium* now known to occur on a member of the Betulaceae.

7. *Phacidium cicatricola* Fuckel Fig. 217.

Jahrb. Nass. Natur. 27/28: (1873/1874). (*ut P. cicatricolum*).

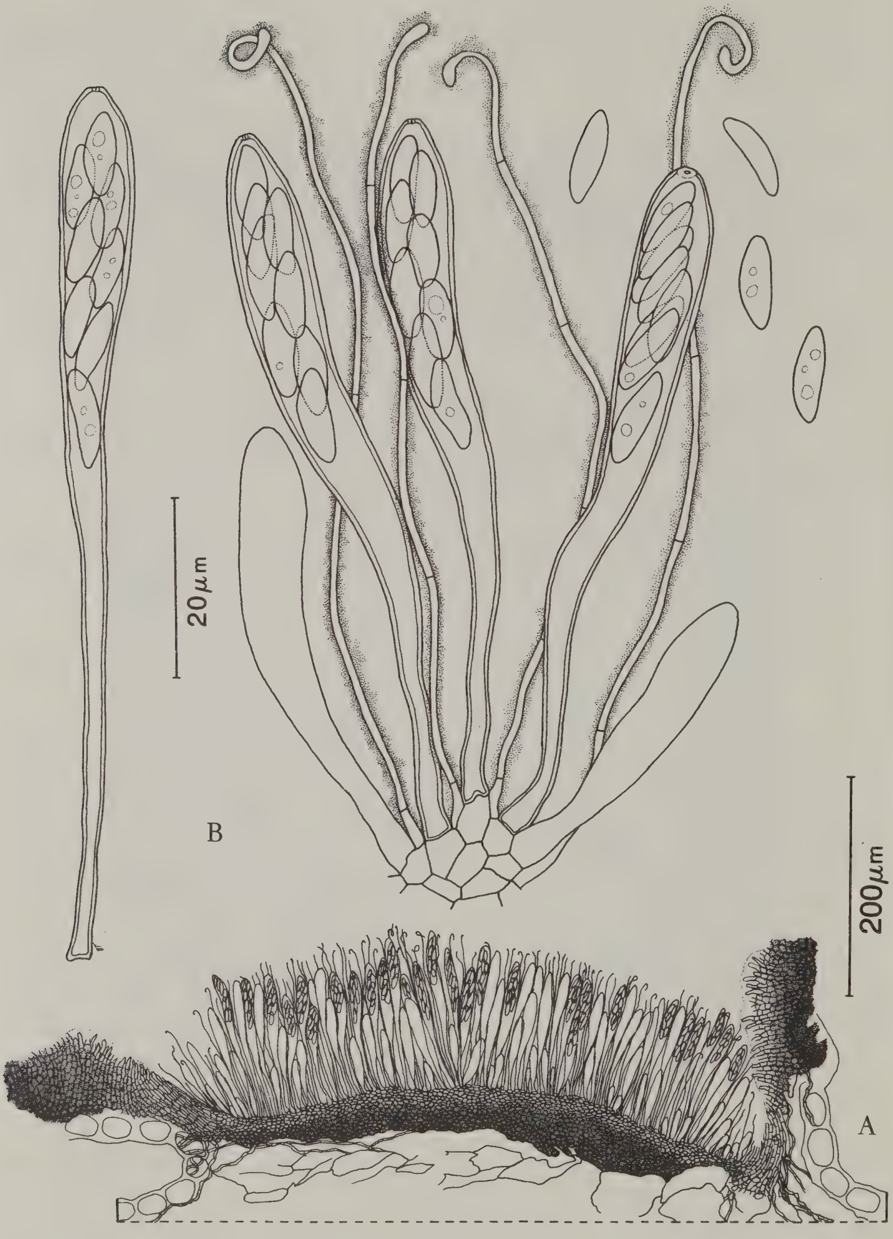
Foliicolous. Ascomata amphigenous, scattered to gregarious, subepidermal, pale yellow-brown, circular to subcircular in outline, raising the overlying host epidermis into cushion-shaped swellings, then splitting the overlying fungal tissue stellately into 3-5 irregular teeth of *textura globulosa*; overlying tissue composed of pale yellow-brown outer pseudoparenchymatous cells with a weak columnar arrangement (when viewed in vertical section), innermost layer of thin-walled, hyaline, smooth-walled periphysoids which taper toward the rounded apices, up to 20 X 2 µm, of 2-4 subcylindrical cells with gelatinizing outer walls invested in mucilage. Hymenium pale yellow-brown, convex, up to 130 µm thick, of asci and paraphyses; subhymenium up to 30 µm thick, hyaline, of *textura angularis* becoming pale yellow toward the basal stroma; basal stroma light brown, of closely packed hyphae which form a *textura globulosa* up to 25 µm thick. Asci club-shaped, apex flattened in the region of the amyloid apical dehiscence mechanism, 112-125 X 6-7.5 ($\bar{x}$ = 119 X 6.5) µm. Ascospores biseriate, ellipsoid, irregularly ellipsoid to subreniform, ends rounded, unicellular, hyaline, often guttulate, smooth-walled, 10-12.5 X 2-3 ($\bar{x}$ = 11 X 2.5) µm, in upper portion of ascus. Paraphyses numerous, filiform, flexuous, subcylindrical, rarely branched, septate, with slightly recurved, swollen, rounded apices, smooth-walled, up to 130 X 1 um, and coated with mucilage.

Habitat: on leaves of *Abies pectinata*.

Known distribution: Austria; Germany.

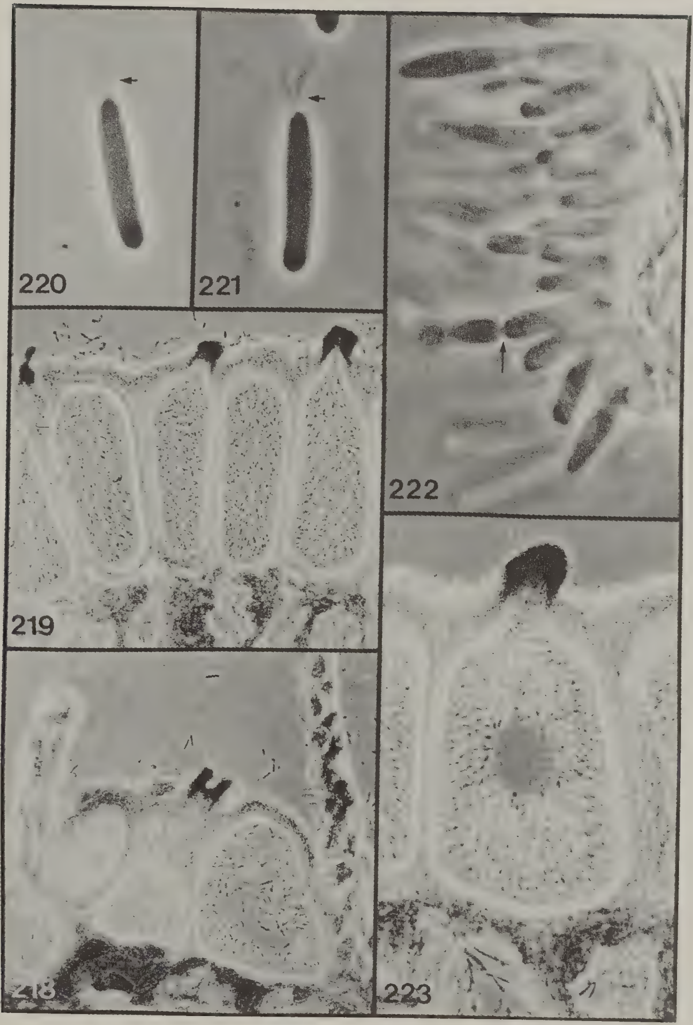
Specimens examined: In DAOM, material authentic for the name, 119830 ex herbier Barbey-Boissier 1037, L. Fuckel, Bavaria; in FH, isotype, Fuckel Fungi Rhenani 2562, Bavaria.

Fuckel (1873/1874) suggested that the anamorph of *P. cicatricola* was similar to that of *P. salicinum* Fuckel. Hoehnel (1925) introduced the name *Ceuthospora cicatricola* Hoehn. for the anamorph of *P. cicatricola*.


20μm
B
200μm
A

217

Phacidium cicatricola. 217. A. V.S. of ascoma. B. Asci, ascospores and paraphyses.



Ceuthospora cicatricola anam. of Phacidium cicatricola. 218. V.S. mature multiloculate conidioma. x 130. 219. V.S. of mature conidioma. x 130. 220, 221. Conidia with fully everted apical appendages (arrows). x 1280. 222. Detail of hymenium, arrow indicates collarette. x 1280. 223. Detail of a single locule of a conidioma, illustrating tissue types. x 190.

Ceuthospora cicatricola Hoehnel Figs. 218-223.
Mitt. Bot. Inst. Techn. Hochsch. Wien 2: 105 (1925).

Foliicolous. Conidiomata pycnidial, compound, amphigenous, often in rows on either side of the midrib, abundant, scattered, gregarious to densely crowded, but not confluent, subepidermal, raising the epidermis into swellings which eventually split into irregular teeth, pulvinate, glabrous, light yellow-brown, with 10-50 locules, 550 µm wide and 2000 µm long; individual locules variable in shape, 50-120 µm diam., up to 230 µm high, bearing individual, papillate ostioles up to 15 µm diam.; wall pseudoparenchymatous, of closely compacted, septate, hyaline to subhyaline, smooth-walled hyphae, which become light yellow-brown toward the apex, forming a *textura porrecta* 10-15 µm wide in the verticalwalls between locules; cells around the ostioles often thick-walled, dark brown, and smooth-walled, forming a *textura globulosa*. Conidiophores simple or branched, septate, or reduced to simple conidiogenous cells (phialides) arising all around the locules, bearing minute collarettes, hyaline, smooth-walled, 7-10 (-15) X 2-3 ($\bar{x}$ = 8.5 X 2.5) µm, invested in a thin layer of mucilage. Conidia blastic-phialidic, non-septate, subcylindrical, straight or sometimes slightly curved, tapering slightly toward the apex, base rounded, hyaline, smooth-walled, 13-15 (-18) X 2 (-3) ($\bar{x}$ = 14 X 2) µm, mean length/width ratio = 7:1, invested in a thin, mucilaginous sheath which becomes an apical appendage.

Habitat: on leaves of *Abies pectinata*.

Known distribution: Austria, Germany.

Specimen examined: In DAOM 119830 ex Herbier Barbey-Boissier 1037 *sub Phacidium cicatricolum* Fuckel fungus spermogonicus, Bavaria, Germany.

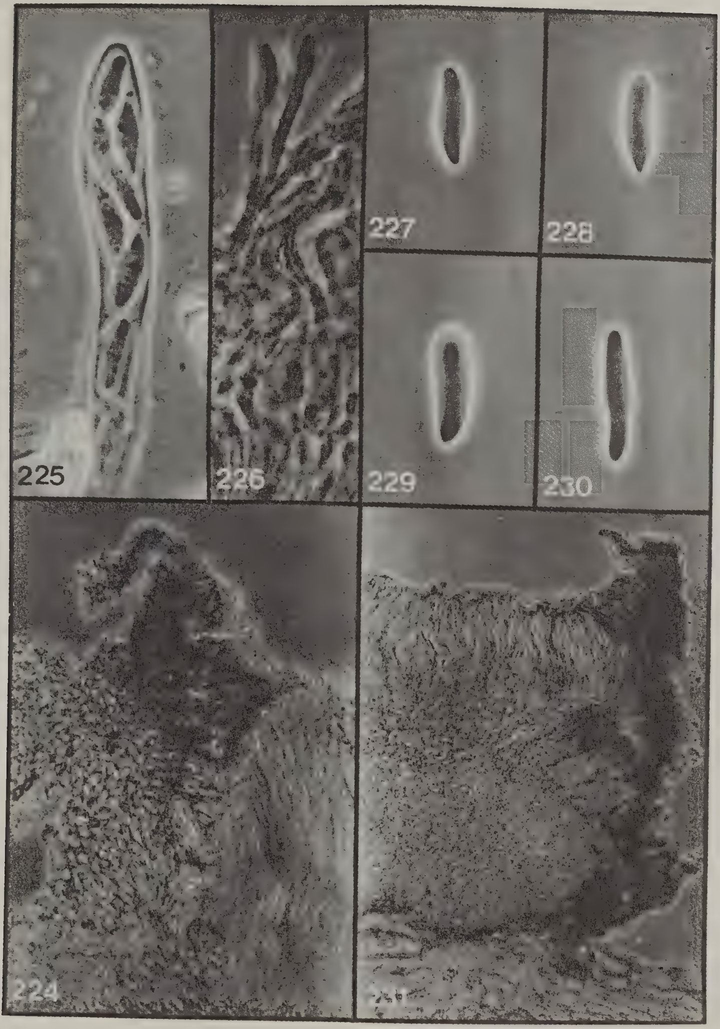
Fuckel (1873/1874) introduced *P. cicatricola* with a description of the teleomorph and a reference to the suspected anamorph. He gave poor illustrations of an ascus and ascospores of the teleomorph, and of a conidium of the anamorph.

Hoehnel (1925) published *Ceuthospora cicatricola* for the anamorph of *P. cicatricola*, and believed that the teleomorph was referable to *P. abietinum*.

Our studies indicate that Hoehnel was wrong. The two species are easily distinguished by their ascus and ascospore dimensions and morphologies, as well as by their anamorphs. The asci of *P. abietinum* are shorter and wider (44-62 X 6-8 µm) than those of *P. cicatricola* (112-125 X 6-7.5 µm), and the ascospores of *P. abietinum* are larger (9-14 X 2.5-3 µm) than those of *P. cictricola* (10-12 X 2-3 µm). The anamorph of *P. cicatricola* is a *Ceuthospora*, while that of *P. abietinum* is an *Apostrasseria*. *P. cicatricola* is a saprobic species, *P. abietinum* is parasitic.

8. *Phacidium coniferarum* (Hahn) DiCosmo, Nag Raj & Kendrick Figs. 224-231.
Can. J. Botany 61: 37 (1983).
≡ *Phacidiella coniferarum* Hahn, Mycologia 49: 227 (1957).
≡ *Potebniamyces coniferarum* (Hahn) Smerlis, Can. J. Botany 40: 352 (1962).
= *Phacidium pulverulentum* Schmidt, in Kunze & Schmidt, Mycol. Hefte 1: 33 (1817).
≡ *P. pulverulentum* Schm., in Kunze & Schm.:Fr., Syst. Mycol. 2: 573 (1823).
(sanctioned, ICBN, Art. 13.1(f)).
= *Pseudophacidium decorticans* Rehm, in Sydow, Mycotheca Marchica no. 854 (1885).
(not validly published *teste* Smerlis (1968)).

Caulicolous and lignicolous. Ascomata scattered to gregarious, often



Phacidium coniferarum ex Krieger material in S. 224. Detail of margin and covering layer of an ascoma. x 310. 225. Ascus and ascospores. x 770. 226. Detail of periphysoids. x 200. 227-230. Ascospores. x 1280. 231. V.S. of portion of an ascoma illustrating basal stroma, subhymenium, hymenium and margin. x 125.

becoming confluent, initially immersed, raising the host tissue into irregular swellings, subcircular to irregular in outline, 500-1000 µm diam., ultimately splitting open irregularly by teeth to expose the hymenium; fungal covering of pale yellow-green, loosely textured, pseudoparenchymatous cells which become brown to purple-brown *textura globulosa*; innermost cells pale purple-brown periphysoids that are KOH$^+$ (green), up to 37X 3-4 um, invested in a pale brown gel with granular inclusions toward the hymenium. Hymenium plane, pruinose, bordered by pale yellow-green furfuraceous cells when dry, of asci and paraphyses, invested in a pale brown gelatinous matrix that is KOH$^+$ (green), and pink in distilled water, up to 105 µm thick; subhymenium of densely interwoven, subhyaline to pale yellow, septate hyphae forming a *textura intricata* up to 35 µm thick; basal stroma of pale yellow-brown *textura globulosa* up to 450 µm thick. Asci club-shaped, 8-spored, 90-105 X 6.5-10 ($\bar{x}$ = 97 X 8) µm, flattened in the region of the amyloid (I$^+$) apical dehiscence mechanism. Ascospores biseriate, irregularly fusiform, ellipsoid, narrowly pyriform to clavate, straight or curved, hyaline to very pale olivaceous-yellow, smooth-walled, 12.5-20 X 3.5-5 ($\bar{x}$ = 16 X 4) µm, mean length/width ratio = 4:1. Paraphyses abundant, septate, simple or branched, up to 105 X 1.5-2 µm, often anastomosing, invested in KOH$^+$ (green) gel.

Habitat: on leaves and branches of *Abies alba*, *A. grandis*, *Cedrus atlantica*, *C. deodara*, *C. libanensis*, *Larix decidua*, *L. leptolepis*, *L. occidentalis*, *L. russica*, *L. sibirica*, *Picea abies*, *Pinus banksiana*, *P. canariensis*, *P. contorta*, *P. mugo*, *P. muricata*, *P. radiata*, *P. strobus*, *P. sylvestris*, *Pseudolarix amabilis*, *Pseudotsuga douglasii*, *P. glauca*, *P. menziesii*, *Sequoia gigantea*, *S. wellingtonia*, *Tsuga canadensis*, *T. heterophyla*.

Known distribution: Belgium; Canada (Quebec); Czechoslovakia; Denmark; England; France; Germany; Iceland; Italy; Netherlands; New Zealand; Norway; Romania; Scotland; U.S.A.; U.S.S.R.

Specimens examined: in S, as *Phacidium pulverulentum*, W. Krieger, Koenigstein, 1897-IX; DAOM 129869, E. Smerlis, Valcartier, Quebec, Canada, 1968-IV-29; DAOM 129883, E. Smerlis, Lac-à-la-Tortue, Quebec, Canada, 1967-IX-10; DAOM 129858, E. Smerlis (as above).

The anamorph is disposed in *Apostrasseria*.

Apostrasseria anamorph of *Phacidium coniferarum*. Figs. 232-238.

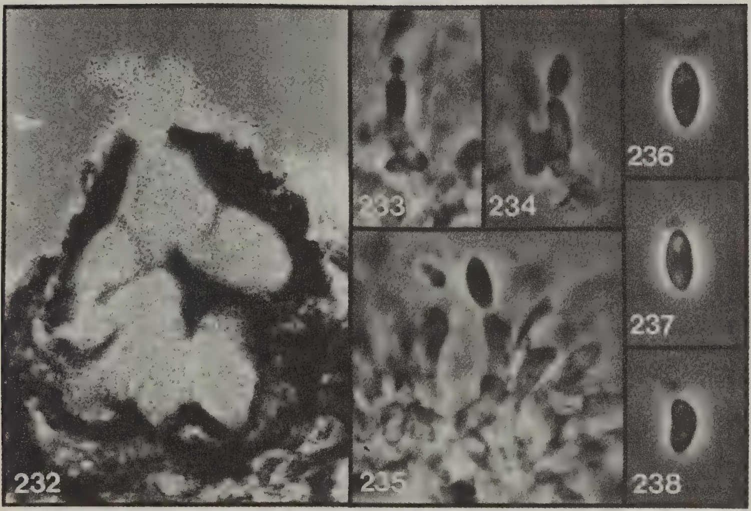
= *Phacidiopycnis pseudotsugae* (Wils.) Hahn, Mycologia 49: 230 (1957).

≡ *Phomopsis pseudotsugae* Wilson, Trans. Bot. Soc. Edinb. 28: 47 (1920).

= *Ligniella pinicola* Naumov., Mat. Nik. Fitop. 5: 7 (1926).

≡ *Discula pinicola* (Naum.) Petrak, in Lagerberg, Lundberg& Melin, Svensk. Skogsvardsfor. Tidskr. 25: 209 (1927).

Caulicolous and lignicolous. Conidiomata pycnidial, scattered to gregarious, often confluent, initially immersed in host cortical layers, raising the host tissue into irregular conical swellings, ultimately rupturing the overlying host tissue, exposing dark brown to black, subconical to pulvinate, irregularly multilocular, ostiolate pycnidia, 170-650 µm diam., wall pseudoparenchymatous, brown to dark brown, of *textura globulosa*, up to 65 µm thick above; olivaceous-brown, up to 20 µm thick below; hyaline to pale olivaceous-yellow toward the hymenium. Conidiophores arising from the innermost cells of the conidioma, branched or simple, septate, hyaline, smooth-walled, 10-15 X 3.5-4 µm, invested in mucilage. Conidiogenous cells phialides, subcylindrical to lageniform, hyaline, smooth-walled, 4-10 X 2.5-3.5 ($\bar{x}$ = 7 X 3) µm, often proliferating 1-3 times. Conidia blastic-phialidic, non-septate, ellipsoid, obovoid, often irregular, apex tapered to a rounded point, base tapered to a truncate dehiscence scar, hyaline,


232
233
234
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236
237
238

Apostrasseria anam. of Phacidium coniferarum. 232. V.S. of multiloculate conidioma. x 125. 233-235. Conidiogenous cells with developing conidia. x 1280. 236-238. Conidia with apical mucilaginous appendages. x 1280.

smooth-walled, 4.5-6.5 X 2-4 ($\bar{x}$ = 5.5 X 3) μm, mean length/width ratio = 1.9:1; usually bearing an irregular, apical, mucilaginous appendage, often bearing both an apical and minute basal mucilaginous appendage.

Habitat: see teleomorph.

Specimens examined: In S, as *P. pulverulentum* in association with teleomorph (q.v.); in DAOM 129833 in association with teleomorph; DAOM 129858 in association with teleomorph; in IMI, 194414 from *Pinus* sp., dried PDA cultures; IMI 195536, dried Oatmeal agar cultures; IMI 192942, dried PDA and Malt agar cultures from *Pinus contorta*, D. B. Redfern, Roslin, Scotland, 1974-V-04; IMI 19241, *ibid*; IMI 33174, F. Petrak, Mycotheca generalis no. 1918, Westfalen, S. Ludwig, 1926-XI; IMI 22611, G. G. Hahn, Kincardine, Scotland, 1926-IV; IMI 22612, *ibid*.

Hahn (1957) introduced *Phacidiella coniferarum* for the teleomorph of *Phacidiopycnis pseudotsugae* (Wilson) Hahn. Using pure culture techniques he was able to show that the two morphs were genetically connected. Hahn (*loc. cit.*) provided a good account of the fungus, both on the host and in pure culture, gave its geographical distribution, and discussed its biology as causal agent of bark necrosis of conifers.

Phomopsis pseudotsugae Wils. was described by Wilson (1920) for a fungus parasitic on *Pseudotsuga douglasii*. The fungus caused a bark necrosis or die-back of young shoots, or both types of injury. Hahn (1930) attempted to study the life histories of several *Phomopsis* species occurring on conifers. Although Hahn brought some closely related species together for the first time, his taxonomy is unreliable because it was not based on a sound knowledge of the anatomy of the species concerned.

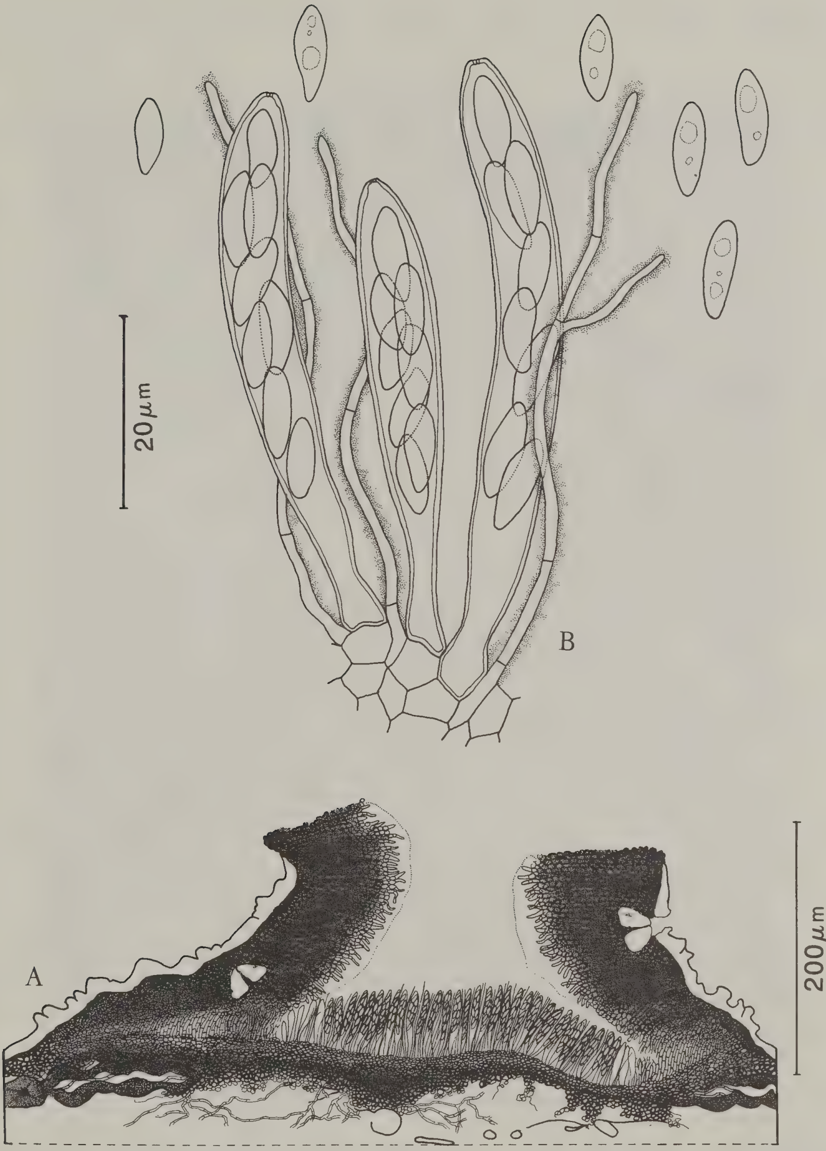
Smerlis (1962) noticed the taxonomic anomalies in the earlier literature, introduced *Potebniamyces coniferarum* (Hahn) Smerlis, and found the fungus in Quebec. Like his predecessors, Smerlis relied too heavily on the published literature, and did not study the Phacidiaceae as a group. Consequently his taxonomic conclusions reflected the misinterpretations of earlier authors. He did, however, provide new information on the development of the teleomorph.

Punithalingam & Gibson (1976) described and illustrated the *Phacidiopycnis pseudotsugae* anamorph of *Potebniamyces coniferarum*. Although these authors elucidated conidiogenesis in *P. pseudotsugae*, they did not fully characterize the conidiomatal anatomy, and did not see the characteristic mucilaginous apical appendages on the conidia. Punithalingam & Gibson (1976) accepted *Potebniamyces* as delimited by Smerlis (1962) and provided a good synopsis to the literature of *P. coniferarum*.

Most recently, Kaarik (1980) provided some interesting information about *Phacidiopycnis pseudotsugae* (*ut Discula pinicola*) in relation to blue-stain of sapwood. Kaarik found that conidia were distributed by air currents. However, we believe that most conidia are water-dispersed. The literature already cited provides adequate data on the biology of the teleomorph, which will not be repeated here.

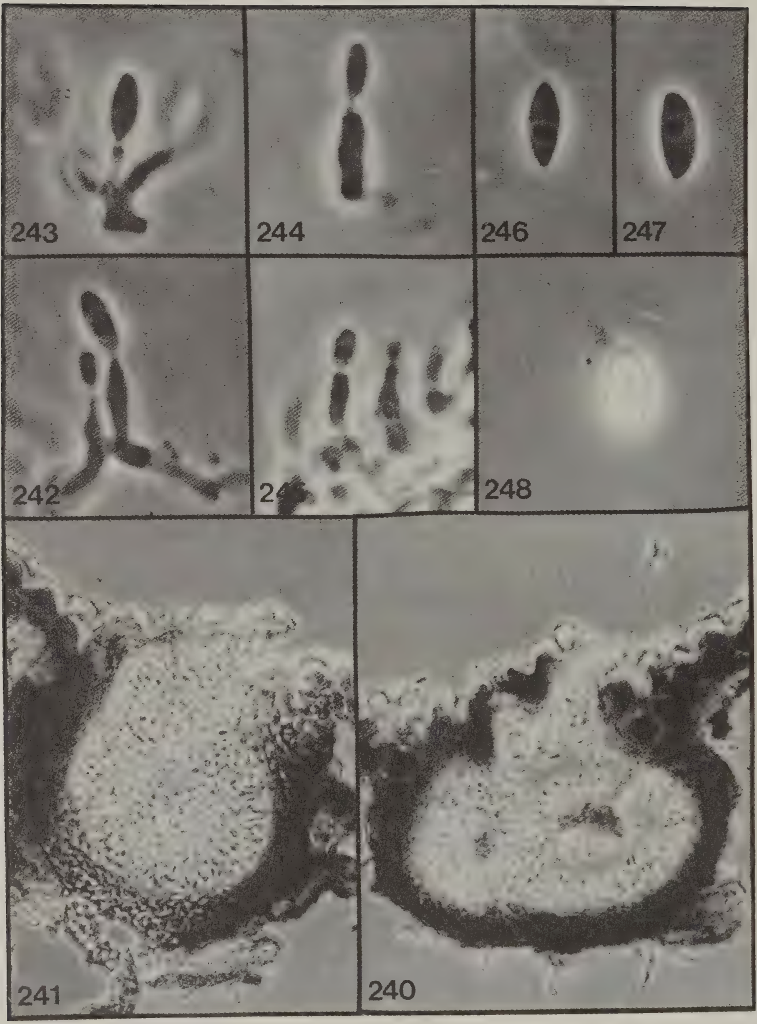
9. *Phacidium dearnessii* DiCosmo, Nag Raj, & Kendrick Fig. 239.
Can. J. Botany 61: 37 (1983).

Foliicolous. Ascomata hypophyllous, scattered, gregarious, often confluent, black, 400-700 μm diam., subcuticular to intraepidermal, subconical, dehiscent by 3-4 irregular teeth; roof of dark brown, external *textura globulosa* becoming paler toward the periphysoids, which are subhyaline to hyaline, smooth-walled, 5-12.5 X 3.5 μm, and embedded in mucilage. Hymenium plane, grey, up to 71 μm thick; subhymenium up to 15 μm thick, hyaline, becoming brown toward the basal stroma; basal stroma up to 35 μm thick, of *textura globulosa*. Asci club-shaped, flattened in the region of the amyloid (I^+) apical dehiscence mechanism, 54-71 X 6-7 ($\bar{x}$ = 62 X 6.5) μm. Ascospores biseriate, ellipsoid to irregularly ellipsoid, ends round, non-septate, hyaline, smooth-walled, usually biguttulate, 6-11 X 3.5-5


20μm
B
A
200μm

239

Phacidium dearnessii. 239. A. V.S. of mature ascoma. B. Asci, ascospores and paraphyses.



240. V.S. of conidioma. x 205. 241. V.S. unilocular conidioma. x 205. 242, 243. Blastic-annellidic conidiogenous cells with developing conidia. x 1280. 244, 245. Phialidic conidiogenous cells with developing conidia. x 1280. 246, 247. Conidia in lactic acid: note that no apical, mucoid appendage is visible. x 1280. 248. Conidium in distilled water, showing mucoid apical appendage. x 1280.

($\bar{x}$ = 8.5 X 4) µm, mean length/width ratio = 2.2:1. Paraphyses simple or branched, septate, apices rounded, hyaline, smooth-walled, 55-70 X 1.5-2 µm, invested in mucilage.

Habitat: on leaves of *Taxus brevifolia*.

Known distribution: Canada (British Columbia).

Specimens examined: in DAOM 105952 (as *Phacidium taxicolum*) ex DAVFP 14991, R. O. Wood, Sloan City, B.C., 1963-V-30.

Growing in close association with this teleomorph were conidiomata of the presumed anamorph, described below.

Apostrasseria robusta Nag Raj anamorph of *Phacidium dearnessii*.
Figs. 240-248.

Foliicolous and caulicolous. Conidiomata on leaves occurring on either side of the midrib, hypophyllous, sometimes epiphyllous, abundant, scattered to gregarious, often two or three becoming confluent, usually multilocular, ostiolate; at first subcuticular then becoming intraepidermal, globose to depressed globose, brown, glabrous, composed of a dark brown *textura globulosa* in the apical region, becoming subhyaline to hyaline toward the hymenium. Conidiophores lining the locules, branched, septate, hyaline, smooth-walled, up to 20 µm tall, often reduced to conidiogenous cells (annellides or phialides), simple, subcylindrical to lageniform, (5-) 7-12 (-15) X 2-3 µm, arising from the innermost hyaline cells of the conidioma and invested in mucilage. Conidia blastic-annellidic, non-septate, more or less ellipsoid, straight or curved with a sub-denticulate base, guttulate, hyaline, smooth-walled, (6-) 7-8 (-9) X 2-3 (-3.5) ($\bar{x}$ = 7.5 X 3) µm, invested in a mucilaginous sheath which becomes everted at maturity to form an irregularly shaped, apical, mucilaginous appendage.

According to collections studied, the teleomorph was referred to *Phacidium taxicola* Dearness & House in Dearness (*ut P. taxicolum* Dearness 1926), the causal agent of snow-blight of *Taxus* spp. DAOM has several collections under *P. taxicola* on *T. brevifolia* from British Columbia, and on *T. canadensis* from eastern Canada and U.S.A. The fungus on *T. canadensis* is referable to *P. taxicola*. But the collections on *T. brevifolia* bore another species of *Phacidium*, and an undescribed anamorph. The pycnidial conidiomata are stromatic, unilocular to irregularly multilocular, with an ostiole surrounded by dark *textura globulosa* (Figs. 240, 241), and have conidiogenous cells lining the locule. Close examination of the conidiogenous cells revealed that both blastic-annellidic and phialidic conidiogenesis occurred in this fungus (Figs. 242-245). This suggests that the proliferating phialide and the annellidic conidiogenous cell are essentially the same. Here the qualitative differences are of degree rather than of kind. The anamorph of *P. dearnessii* is *Apostrasseria robusta*, which has significant differences in host range and measurements when compared to the *Apostrasseria fusiformis* anamorph of *P. taxicola* (Nag Raj 1983).

P. dearnessii is most readily distinguished from *P. taxicola* on the basis of its *Apostrasseria* anamorph, which has stromatic conidiomata, predominantly blastic-annellidic conidiogenesis, and conidia 6-9 X 2-3.5 µm. The *Apostrasseria* anamorph of *P. taxicola* has less stromatic conidiomata, phialidic conidiogenesis, and fusiform conidia, 8-14 X 3-4 µm.

Nag Raj (1979, 1983) provided useful information and illustrations of *P. dearnessii* and *P. taxicola*.

10. *Phacidium eucalypti* Beaton & Weste, Trans. Brit. Mycol. Soc. 68 (1): 76 (1977).

Foliicolous. Ascomata amphigenous, scattered to gregarious, discrete, initially immersed, subcuticular, forming orbicular swellings, 300-700 µm diam., ultimately erumpent, rupturing by 3-5 teeth to expose the hymenium;

overlying fungal tissue of dark brown outer pseudoparenchymatous cells forming a *textura globulosa*, up to 90 µm thick above, brown toward the interior, innermost layer of hyaline periphysoids. Hymenium plane, yellow-brown, of asci and paraphyses, up to 90 µm thick; subhymenium of pale yellow-brown *textura angularis* up to 10 µm thick; basal stroma of pale brown *textura globulosa* up to 10 µm thick. Asci club-shaped, 8-spored, 62-87 X 8-10 ($\bar{x}$ = 74 X 9) µm, with an amyloid (I$^+$) apical dehiscence mechanism. Ascospores biseriate, ellipsoid to ellipsoid-fusiform, straight or curved, 12.5-17 X 3.5-4 ($\bar{x}$ = 14.5 X 3.5) µm, mean length/width ratio = 4:1. Paraphyses simple, subcylindrical, septate, hyaline, smooth-walled, up to 90 µm tall, 1-1.5 µm wide below, up to 2.5 µm wide above, with rounded apices; embedded in mucilage.

Habitat: on fallen leaves of *Eucalyptus* sp.

Known distribution: Australia (Victoria).

Specimen examined: In MELU, Holotype, G. Beaton 379, Jumping Creek Reserve, Warandyte, Victoria, Australia, 1975-X.

Beaton & Weste (1977) introduced and illustrated *P. eucalypti* for a fungus found on fallen *Eucalyptus* sp. leaves. *P. eucalypti* is the only known species of *Phacidium* that occurs on any member of the Myrtaceae, and is the only teleomorphic species of the Phacidiaceae known to occur south of latitude 34°S. The species is saprobic, and we predict that its anamorph, when discovered, will be referable to *Ceuthospora*.

11. *Phacidium gaeumannii* (Mueller) DiCosmo, Nag Raj & Kendrick
Figs. 249-252.
Can. J. Botany 61: 37 (1983).
≡ *Pseudophacidium gaeumannii* Mueller, Phytopath. Z. 48: 209-210 (1963).

Caulicolous. Ascomata scattered to gregarious, often 2 or 3 arising from a common basal stroma, initially immersed in outer host cortex, ultimately erumpent, black, scabrous, 500-1000 µm diam., up to 1000 µm tall, shortly stipitate, basal portion immersed; fungal covering layer splitting open irregularly by teeth, outer layers of tissue black, carbonous, stromatic, becoming brown *textura globulosa* toward the interior, up to 50 µm thick; innermost layer of subulate to subcylindrical, simple or branched, septate, hyaline, smooth-walled periphysoids, 25-40 X 1.5-2.5 µm, invested in mucilage. Hymenium plane, of asci and paraphyses, up to 85 µm thick; subhymenium of subhyaline *textura oblita* arising from a pale brown, medullary excipulum, 500-600 µm thick, of *textura oblita* then *textura globulosa* below; outer layer of black to brown carbonous tissue grading to pale brown *textura oblita* toward the interior. Asci club-shaped, 8-spored, clavate, 60-85 X 8-11 ($\bar{x}$ = 75 X 9) µm, tapered slightly above, flattened in the region of the the amyloid (I$^+$) apical dehiscence mechanism. Ascospores biseriate, irregularly ellipsoid to fusiform, non-septate, guttulate, hyaline, smooth-walled, 8-12 X 3-4 ($\bar{x}$ = 11 X 3.5) µm, mean length/width ratio = 3.1:1. Paraphyses subcylindrical, flexuous, simple or branched, septate, hyaline, smooth-walled, 70-85 X 1.5-2.5 µm, invested in mucilage.

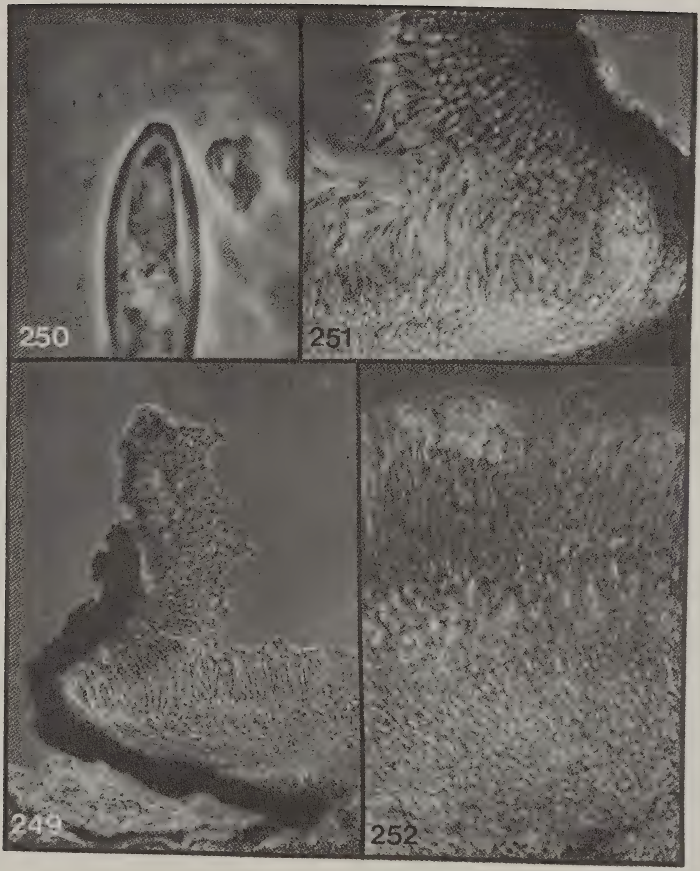
Habitat: on branches of *Larix decidua*.

Known distribution: Switzerland.

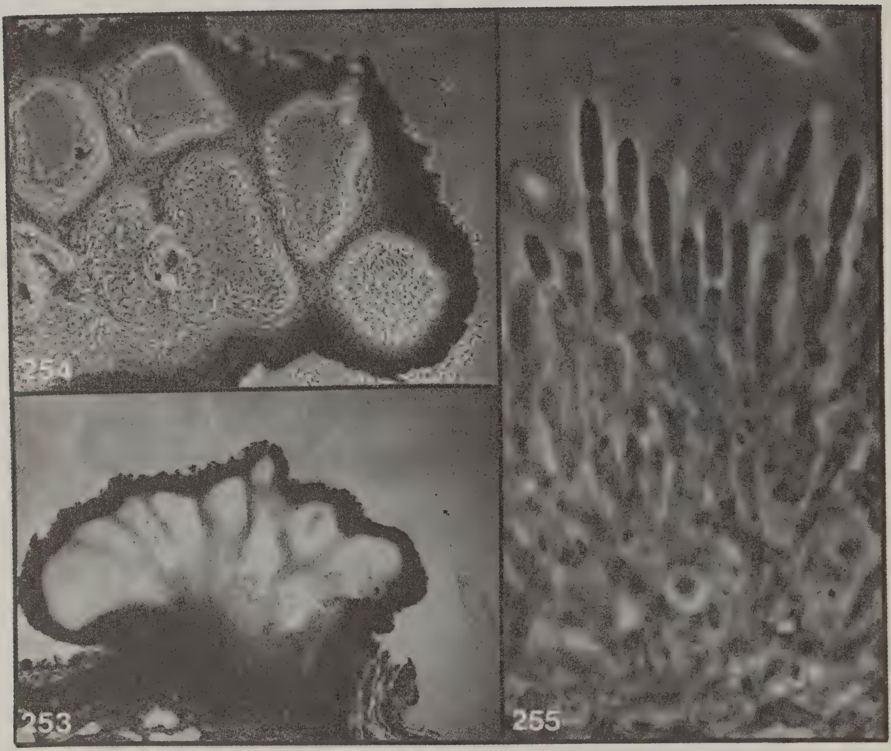
Specimens examined: in ZT, Holotype, E. Mueller, Kt. Wallis, Aletschwald, Moraenweg, 1962-IX-08; M. Egger, Kt. Wallis, Graechen, Waldwegegen, Hannigalp, 1963-VI-03.

The genetic connection between *Pseudophacidium gaeumannii* and its *Ceuthospora* anamorph was demonstrated in pure culture by Egger (1968).

Ceuthospora anamorph of *Phacidium gaeumannii*. Figs. 253-255.



Phacidium gaeumannii. 249. V.S. of ascoma, showing margin, basal stroma, hymenium and covering layer. x 190. 250. Ascus apex with amyloid dehiscence mechanism. x 1200. 251. Detail of covering layer. x 480. 252. Detail of subhymenium and basal stroma. x 480.



Ceuthospora anam. of Phacidium gaeumannii. 253. V.S. multilocular conidioma. x 50. 254. Detail of conidioma. x 125. 255. Conidiogenous cells with conidia, and subhymenium. x 1280.

Caulicolous. Conidiomata pycnidial, stromatic, scattered to gregarious, initially immersed in cortical layers of host, ultimately erumpent, scabrous, dark brown to black, irregularly pulvinate to subspherical, stoutly stipitate, stipe partly or wholly immersed, irregularly multilocular, with each locule having a separate ostiole, 500-1500 µm diam.; individual locules globulose, depressed globose to irregular, 30-120 X 50-200 µm; outer wall 20-30 µm thick, of black to dark brown carbonous cells, becoming brown textura globulosa ultimately grading into a textura oblita, 15-40 µm thick. Conidiophores lining the locules, branched, rarely simple, septate, hyaline, smooth-walled, 20-25 X 2-2.5 ($\bar{x}$ = 22 X 2.5) µm, embedded in mucilage. Conidiogenous cells phialides, with minute flaring collarettes, subcylindrical, tapered above, hyaline, smooth-walled, 5-12 X 2 ($\bar{x}$ = 8 X 2) µm, embedded in mucilage. Conidia blastic-phialidic, subcylindrical, tapered above, base rounded except for a minute dehiscence scar, hyaline, smooth-walled, 8-11 X 2-2.5 ($\bar{x}$ = 9 X 2) µm, mean length/width ratio = 4.5:1, partly invested in a mucilaginous sheath which becomes everted at maturity to form an irregular to funnel-shaped, apical appendage.

Habitat: on branches of Larix decidua.

Known distribution: Switzerland.

Specimens examined: see teleomorph.

Mueller (1963) described Pseudophacidium gaeumannii from branches of Larix decidua. He provided a detailed description and illustration of the teleomorph, but was less precise about the conidiogenous cells and conidia of the anamorph. Mueller did not record the amyloid (I$^+$) reaction of the ascus dehiscence ring (Fig. 250, herein), and did not stress the characteristic arrangement of the columns of pseudoparenchymatous cells in the fungal roof (Figs. 249, 251, herein). Although he described the anamorph (Figs. 253-255) in detail, Mueller did not emphasize its taxonomic significance for the holomorph.

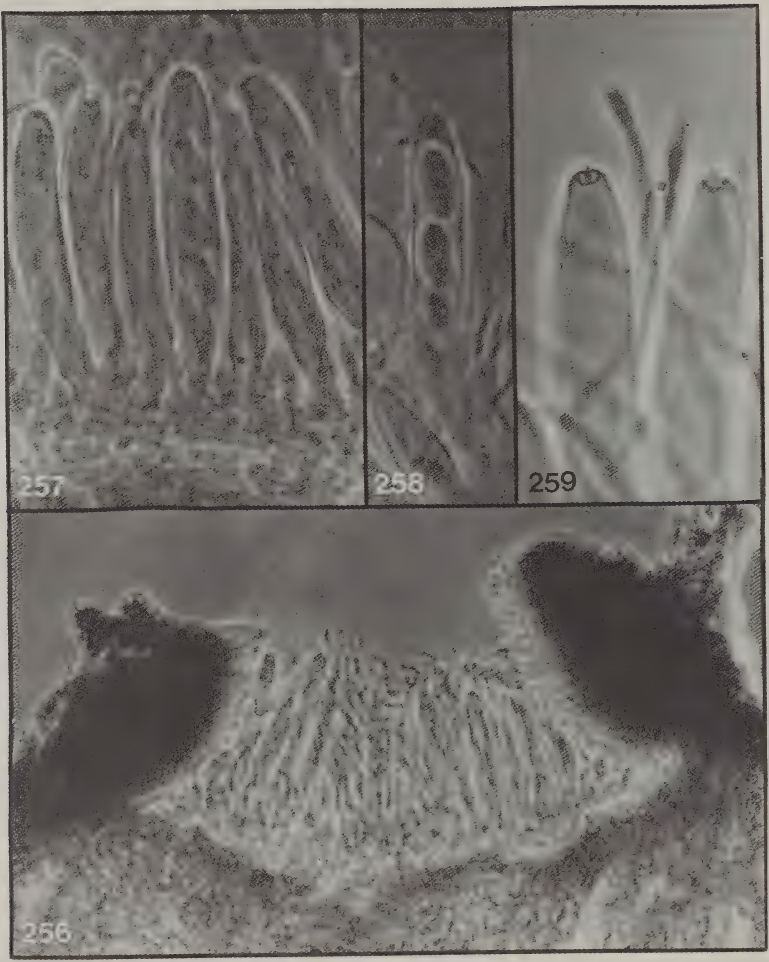
Egger (1968) studied the morphology and biology of species of Pseudophacidium. She accepted Pseudophacidium gaeumannii, provided an expanded description, and illustrated both anamorph and teleomorph.

Pseudophacidium gaeumannii is best placed in Phacidium. The anatomy of the ascoma, the amyloid ascal dehiscence mechanism, and the anamorph, all support this disposition. Phacidium gaeumannii seems to have an isolated position among Phacidium spp. with Ceuthospora anamorphs. The ascoma morphology is the most complex in this group. P. gaeumannii might be confused with P. coniferarum on the basis of ascoma morphology. However, P. coniferarum has irregularly shaped ascospores and an Apostrasseria anamorph. The Ceuthospora anamorph of Phacidium sherwoodiae is similar to the anamorph of P. gaeumannii, but the latter is easily distinguished by its larger conidia and distinctive teleomorph.

12. Phacidium grande DiCosmo, Nag Raj & Kendrick Figs. 256-259.

Can. J. Botany 61: 37-38 (1983).

Foliicolous or caulicolous. Ascomata epiphyllous, scattered to gregarious, often confluent, black, up to 400 µm diam., subcuticular to intraepidermal, forming subconical swellings, then splitting the fungus roof into 3-4 teeth; the roof composed of dark brown to black textura globulosa; innermost layer of periphysoids, 10-12 X 3-3.5 µm, with rounded apices, composed of 2 to 3 cells invested in mucilage. Hymenium grey, plane, up to 85 um thick; subhymenium hyaline, subhyaline toward the basal stroma, of textura globulosa up to 15 µm thick; basal stroma of textura globulosa up to 5 um thick. Asci club-shaped, flattened in the region of the amyloid (I$^+$) apical dehiscence ring, 65-75 X 8-9 ($\bar{x}$ = 70 X 8.5) µm, usually containing 4 mature ascospores, but often with 4-8 spores. Ascospores uniseriate, ellipsoid, non-septate, guttulate, hyaline, smooth-walled, 11-16 X 5.7 ($\bar{x}$ = 13 X 6) µm, mean length/width ratio = 2:1. Paraphyses branched or



Phacidium grande. 256. V.S. of ascoma. x 500. 257. Asci and subhymenium. x 770. 258. Two ascospores in ascus. x 770. 259. Detail of amyloid ascus dehiscence mechanisms. x 1280.

simple, septate, with slightly swollen apices, hyaline, smooth-walled, 65-85 X 1.5 µm, embedded in mucilage.

Habitat: on leaves and twigs of *Ledum groenlandicum*.

Known distribution: Canada (Quebec).

Specimen examined: In DAOM 161166, Holotype, ex herb. S.A. Redhead 2186, Lac St. Jean, Quebec, Canada, 1976-IX-04.

The anamorph of *P. grandis* is unknown.

P. grande seems closely related to *P. vestergrenii* (Rehm) B. Erikss., (Eriksson 1970). Both species usually bear 4-spored asci, although some asci of *P. vestergrenii* were found to have 4 apparently mature ascospores and 2-4 other (degenerate?) ascospores.

The niches of *P. grande* and *P. vestergrenii* appear to be similar, but their distributions are different. *P. vestergrenii* is known from Finland, Sweden and the U.S.S.R. (Eriksson 1970). *P. grande* is known only from Quebec, Canada. *P. grande* can be distinguished from *P. vestergrenii* (q.v.) by its more stromatic ascoma, prominent, amyloid, ascus dehiscence mechanism, and its wider ascospores.

13. *Phacidium heteromelis* Phillips & Harkness Fig. 260-263.
Grevillea 13: 23 (1884).

Foliicolous. Ascomata epiphyllous to amphigenous, scattered to gregarious, usually separate, sometimes confluent, black, circular to irregular in outline, up to 450 µm diam., initially immersed, intraepidermal to subepidermal, raising the epidermis into swellings, overlying fungal and host tissues rupturing stellately; fungus roof of dark brown outer pseudoparenchymatous cells forming a *textura globulosa*; pale yellow-brown toward the interior. Hymenium plane, pale yellow-brown, up to 95 µm thick, paraphyses sometimes extending up to 20 µm above the asci; subhymenium hyaline to subhyaline, of *textura angularis* up to 12 µm thick, pale yellow toward the basal stroma which is of *textura globulosa* up to 20 µm thick. Asci club-shaped, 8-spored, flattened in the region of the amyloid (I^+) apical dehiscence mechanism, 65-80 X 6-9 ($\bar{x}$ = 73 X 7.5) µm. Ascospores biseriate near the ascus apex, uniseriate below, fusiform to ellipsoid, straight or slightly curved, ends round, non-septate, usually guttulate, hyaline, smooth-walled, 10-14 X 2-3 ($\bar{x}$ = 12 X 2.5) µm, mean length/width ratio = 4.8:1. Paraphyses simple or branched, septate, apices slightly swollen, up to 100 X 1.5-2.5 µm, invested in mucilage.

Habitat: on leaves of *Photinia arbutifolia*.

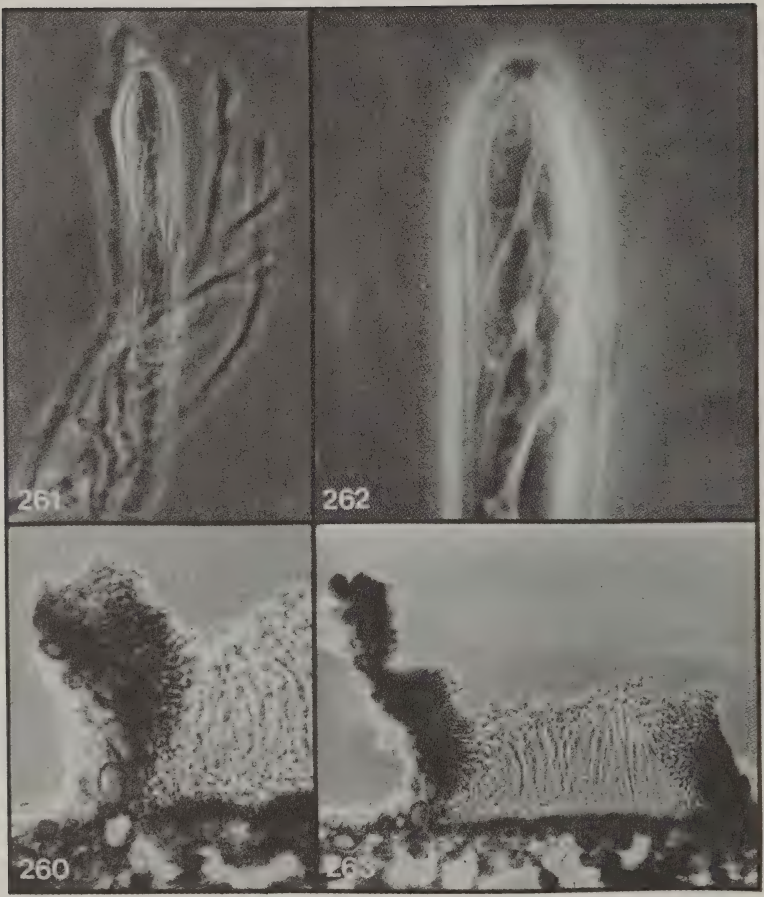
Known distribution: U.S.A. (California).

Specimen examined: In BPI, Holotype 2124, Harkness, Lone Mountain, San Francisco, Calif., U.S.A., 1881-II.

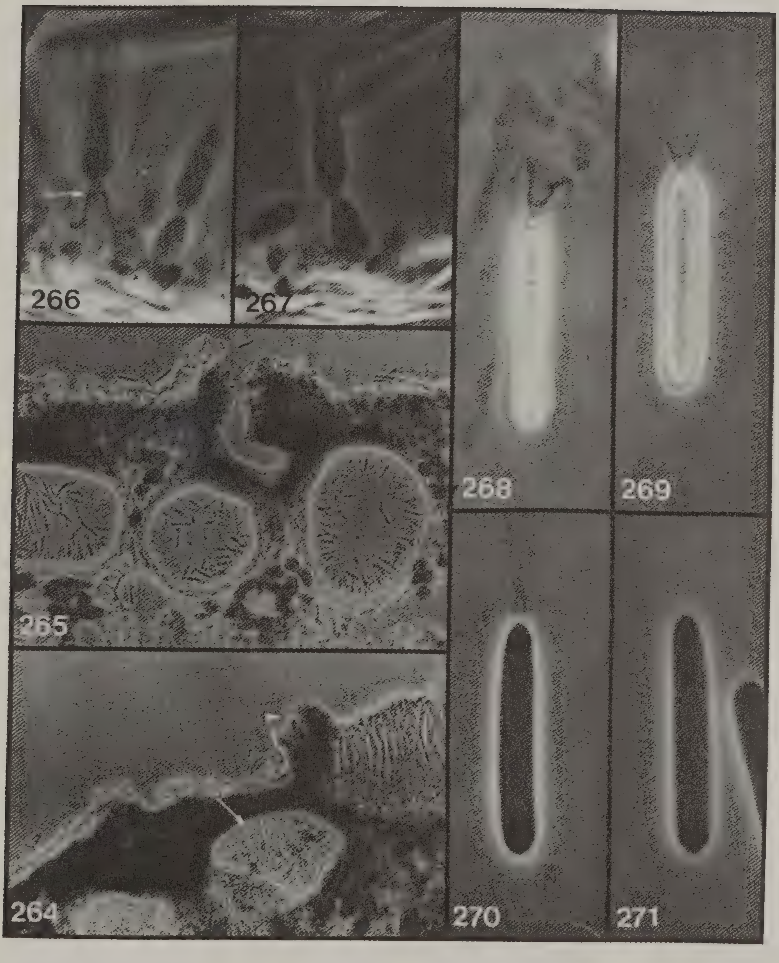
Often intimately associated with the teleomorph were conidiomata of the presumed *Ceuthospora* anamorph.

Ceuthospora anamorph of *P. heteromelis*. Figs. 264-271.

Foliicolous. Conidiomata pycnidial, hypophyllous, scattered to gregarious, usually in groups of 2 or 3, initially immersed, subepidermal, globose to depressed globose, unilocular, up to 220 µm diam., sharing a mutual area of dehiscence bordered by brown *textura globulosa* which forms a loosely textured furfuraceous border toward the surface; wall of pale yellow angular cells forming a *textura angularis* up to 10 µm thick, subhyaline to hyaline toward the hymenium, becoming brown *textura globulosa* above. Conidiogenous cells phialides, often proliferating percurrently 1-3 times, arising from the innermost hyaline cells, all around the locules, subcylindrical, hyaline, smooth-walled, 5-12 X 2.5-3 µm, invested in mucilage. Conidia blastic-phialidic, subcylindrical, slightly tapered above, base



Phacidium heteromelis. 260. Detail of covering layer. x 150. 261. Ascus and paraphyses in mucilaginous matrix. x 770. 262. Detail of ascus apex. x 1280. 263. V.S. ascoma. x 125.



Ceuthospora anam. of Phacidium heteromelis. 264. Detail of anamorph (arrow) in intimate contact with teleomorph (arrowhead). x 125. 265. V.S. conidiomata of anamorph. x 150. 266, 267. Conidiogenous cells with developing conidia, arrow indicates percurrent proliferation. x 1280. 268, 269. Conidia in distilled water: appendage clearly visible. x 1280. 270, 271. Conidia in lactic acid. x 1280.

rounded except for a minute scar, hyaline, smooth-walled, (12.5-) 18-22 X 3 ($\bar{x}$ = 20 X 3) µm, mean length/width ratio = 6.8:1, invested in a partial mucilaginous sheath which becomes everted at maturity to form an irregular to funnel-shaped apical appendage.

Phillips & Harkness (1884) described P. heteromelis from the underside of dead leaves. We found that the ascomata were often amphigenous. Phillips & Harkness made no mention of the Ceuthospora sp. that is abundant and in close asociation with the teleomorph.

Saccardo (1884) repeated the diagnosis provided for P. heteromelis by Phillips & Harkness (Saccardo cited 'Grev. XII. p. 23' as the volume of publication; the description appeared in volume 13).

Our measurements of ascospores agree with those of Phillips & Harkness, but we found several morphological features they did not describe. Most significantly, we found that P. heteromelis has a Ceuthospora sp. anamorph. Although we have not confirmed this connection in pure culture, the anamorph (Fig. 264, arrow) may arise from the same stroma as the teleomorph. The Ceuthospora anamorph of P. heteromelis appears to be exceptional in that its phialides (Fig. 266, arrow) proliferate percurrently. Its conidia are also the largest of any species of Ceuthospora treated in this study.

P. heteromelis is similar to P. arbuti, but its asci are shorter, and the two species are easily distinguished by their anamorphs. Although both belong in Ceuthospora, that of P. heteromelis has larger conidia.

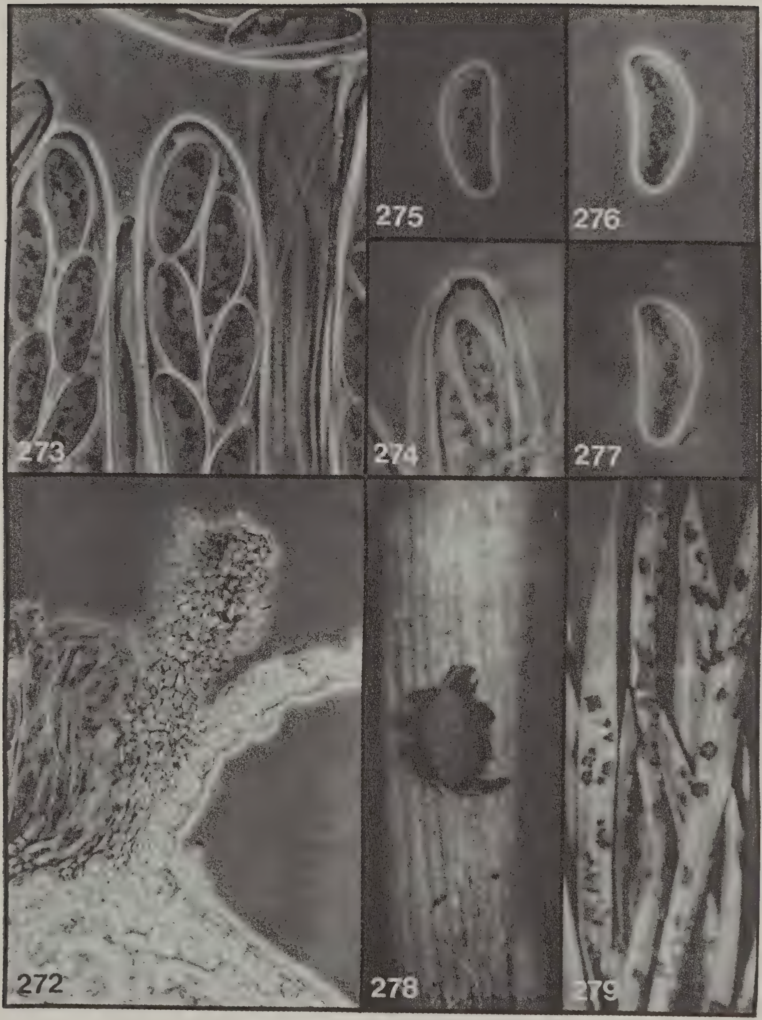
14. Phacidium infestans Karsten Figs. 272-279.
Hedwigia 25: 232 (1886).
= P. infestans var. hikmetae Bremer, Ismen, Karel. & H., & M. Ozkan, Rev. Fac. Sci. Univ. Istanbul Ser. B. 12: 164 (1947).
= Phragmonaevia gigaspora Gremmen, Sydowia 7: 141 (1953), teste Reid & Pirozynski (1968).
≡ Gremmenia gigaspora (Grem.) Korf, Mycologia 54: 22 (1962), teste Reid & Pirozynski.

Foliicolous. Ascomata amphigenous, scattered, gregarious to densely crowded, often confluent, circular to irregular in outline, 400-1000 µm diam., subepidermal to intrahypodermal, raising the overlying fungal and host tissues into 4-8 irregular teeth which become reflexed to expose the hymenium at maturity; fungal roof of brown, outer textura globulosa up to 40 µm thick above, brown toward the interior; innermost layer of hyaline, smooth-walled, periphysoids up to 10 µm long and invested in mucilage. Hymenium pale amber when dry, cream to pale yellow when rehydrated, up to 125 µm thick; subhymenium of densely crowded, branched, septate, hyaline, smooth-walled hyphae forming a textura angularis 10-13 µm thick. Asci club-shaped, 8-spored, tapering toward the base, stipitate, flattened in the region of the amyloid (I^+) dehiscence mechanism, 100-125 X 12-15 ($\bar{x}$ = 112 X 13) µm. Ascospores biseriate, elongate-ellipsoid, straight or curved to subreniform, non-septate, minutely guttulate, hyaline, smooth-walled, 13-25 X 7-8 ($\bar{x}$ = 19 X 6.5) µm, mean length/width ratio = 3:1. Paraphyses simple or branched, septate, hyaline, smooth-walled, up to 125 X 1.5 µm, invested in mucilage.

Habitat: on leaves of Pinus sylvestris, Juniperus communis teste Vleugel (1911), Juniperus sp. teste Holm & Holm (1977), P. contorta teste Roll-Hansen (1978), P. resinosa and Picea glauca teste Pomerleau (1942).

Known distribution: Canada (Quebec); Finland; France; Norway; Sweden; Turkey; U.S.S.R.

Specimens examined: In BPI, C. Roumeguère Fungi selecti exsiccati 4331, P. A. Karsten, Finland, 1887-XI; in DAOM 120425, I. Schirajewski, Tambor, Russia, 1915-IX-25; DAOM 105364, V. Kiyala, Helsinki, Finland, 1945-V-27; DAOM 43875, Fungi Fennici, V. Kiyala, Finland, 1948-X-21; in IMI, 12008, J.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Phacidium infestans ex DAOM 43875. 272. Detail of fungal covering layer of ascoma. x 325. 273. Apical portions of asci, with ascospores. x 770. 274. Detail of amyloid ascus apex. x 770. 275-277. Ascospores. x 770. 278. Habit of ascoma. x 20. 279. Ascomata on host. x 4.

Vleugel, Umeå, Sweden, 1923; IMI 234634, slide ex K. Roumeguère Fungi selecti exsiccati 4331, P. A. Karsten, 1887-X; in S. (*sub* *P. lacerum*), Jaczewski, 1904; ex herb. Rehm, P. A. Karsten, Finland, 1887-XI.

Karsten (1886) introduced the binomial *Phacidium infestans* for a fungus found on blighted *Pinus sylvestris* leaves. The species has been recognized as an aggressive pathogen of *Pinus sylvestris*, and an extensive literature concerning the systematics, biology, and control of *P. infestans* has subsequently developed (Bjorkman 1942, 1971; Gremmen 1953; Kaasa 1971; Kangas 1940; Klingstrom & Lundberg 1978; Korf 1962; Krutov 1978; Kurkela 1968, 1975; Massee & Crossland 1905; Nechaeva 1969; Pehrson 1948; Petrak 1962; Pomerleau 1942; Reid & Pirozynski 1968; Roll-Hansen 1975, 1978; Rummukainen 1971; Spaulding 1956, 1961; Terrier 1942; Vleugel 1911).

Reid & Pirozynski (1968) reviewed the history of the name *Gremmenia* Korf and its type species *G. gigaspora* (Gremmen) Korf, and reduced the genus and the species to synonymy with *Phacidium* and *P. infestans* (*sensu* Petrak, including *P. pini-cembrae* (Rehm) Terrier) respectively. We agree with their conclusions, and refer the reader to their admirable account.

Terrier (1942) introduced *P. pini-cembrae* for a fungal pathogen of *Pinus cembra* collected in Switzerland. Terrier distinguished *P. pini-cembrae* from the morphologically similar *P. infestans* on the basis of the different hosts and the consistently larger ascospores found in *P. pini-cembrae*.

Petrak (1962) considered *P. infestans* and *P. pini-cembrae* conspecific. Presumably, Reid & Pirozynski (1968) supported this view.

P. infestans and *P. pini-cembrae* are morphologically similar (Minter & Millar 1980; Millar & Minter 1980), but they can be distinguished, albeit with difficulty, on the basis of their hosts, and their ascus and ascospore morphologies. We have found that *P. pini-cembrae* is restricted to the convex leaf surface of five-needled pines. The asci (95-112 X 12-15 µm) contain elongate-ellipsoid ascospores (13-23 X 5-6 µm). In contrast, *P. infestans* occurs on two-needled pines, *Juniperus* spp. and *Picea* sp., and the ascomata are amphigenous. The asci (100-125 X 12-15 µm) contain elongate-ellipsoid, straight, curved or curved-fusiform to sublunate ascospores (13-25 X 7-8 µm) that are slightly wider than those of *P. pini-cembrae*. *P. infestans* is boreal, while *P. pini-cembrae* is subalpine. The two species are nevertheless easily confused.

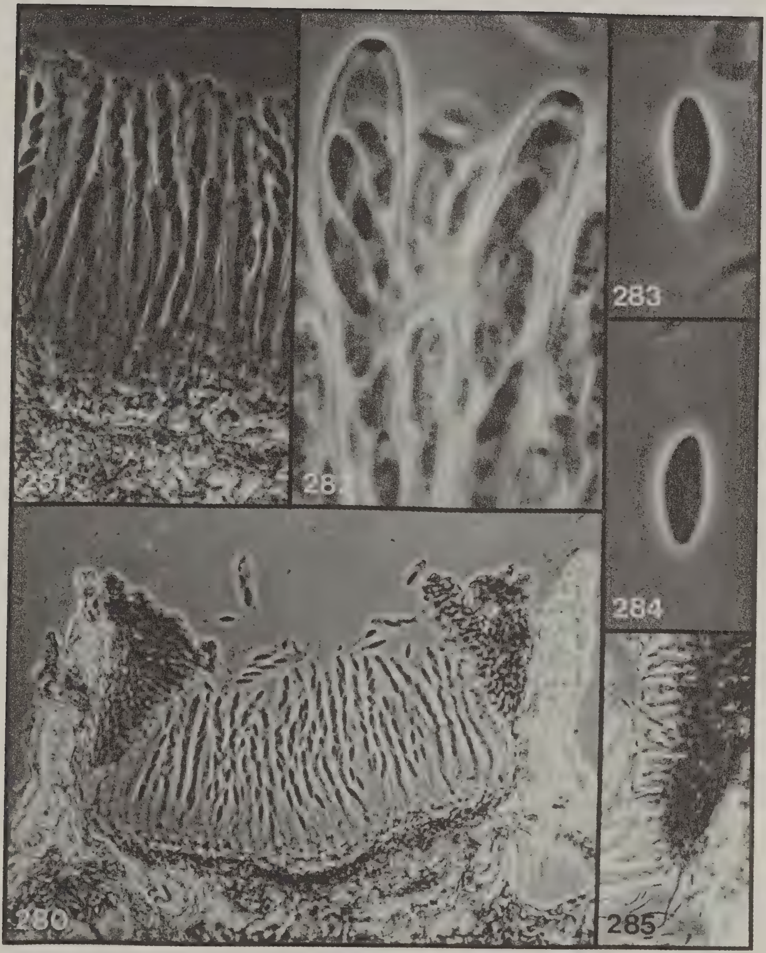
According to Spaulding (1956), *P. infestans* is native to north-eastern U.S.A., eastern Canada, and Europe north of lat. 60°N.

Spaulding (1956, 1961) reported *P. infestans* from *Juniperus chilensis* (Texas), *J. sabina* (Massachusetts and New York, U.S.A., and Sweden), *Picea abies* (Sweden), *Pinus cembra* (Sweden), *P. mugo* (Finland, Norway and Sweden).

Bremer et al. (1947) introduced *P. infestans* Karst. var. *hikmetae* Bremer, Ismen, Karel, & H. & M. Ozkan for a fungus found on *Pinus sylvestris* in Turkey. The fungus was poorly described and distinguished from the type variety, *P. infestans* var. *infestans*, on the basis of the smaller ascomata. The asci were found to fall in the range of '82-131 X 12.5-18.5 µ' and the ascospores were cited as '12.5-29 X 4-10 µ *plerumque* 17-19 X 7-9 µ.' Bremer et al. did not designate a holotype and provided no diagnostic illustrations.

We have not been able to locate the type or any material of *P. infestans* var. *hikmetae*. The salient dimensions fall well within those of typical *P. infestans*. We consider *P. infestans* var. *hikmetae* a superfluous taxon.

15. *Phacidium lacerum* Fr.:Fr. Figs. 280-285.
Syst. Mycol. 2: 575 (1823).
≡ *P. lacerum* Fr., Observ. Mycol. 2: 313 (1818).



Phacidium lacerum ex Thuemen 717 in NY. 280. V.S. ascoma. x 205. 281. Detail of hymenium. x 320. 282. Ascus apices, showing amyloid dehiscence mechanism. x 1280. 283, 284. Ascospores. x 1280. 285. Detail of margin showing periphysoids. x 310.

Foliicolous. Ascomata amphigenous, scattered to gregarious, often crowded but usually discrete, initially immersed, subhypodermal, raising the overlying host and fungal tissues into pulvinate swellings, 300-2000 µm diam., ultimately splitting open irregularly by 3-5 teeth to expose the hymenium; fungal roof of pseudoparenchymatous cells forming a *textura globulosa*, paler toward the interior, innermost layer of smooth-walled periphysoids with gelatinizing outer walls, invested in mucilage. Hymenium plane, grey-yellow, up to 110 µm thick, of asci and paraphyses; subhymenium of crowded, septate, smooth-walled hyphae forming a hyaline *textura angularis* up to 20 µm thick, merging with a brown basal stroma of *textura epidermoidea* up to 25 µm thick. Asci club-shaped, 8-spored, with an amyloid (I^+) apical dehiscence mechanism, 70-110 X 7-10 ($\bar{x}$ = 93 X 8) µm. Ascospores biseriate in the upper portion of the ascus, ellipsoid to irregularly ellipsoid, non-septate, guttulate, hyaline, smooth-walled, 9.5-12.5 X 3-3.5 ($\bar{x}$ = 11 X 3.5) µm, mean length/width ratio = 3.2:1. Paraphyses usually simple, septate, hyaline, up to 115 X 1-1.5 µm, invested in copious mucilage.

Habitat: on fallen leaves of *Abies* sp., *Juniperus* sp. *Pinus nigra*, *P. sylvestris* and *Pseudotsuga menziesii*.

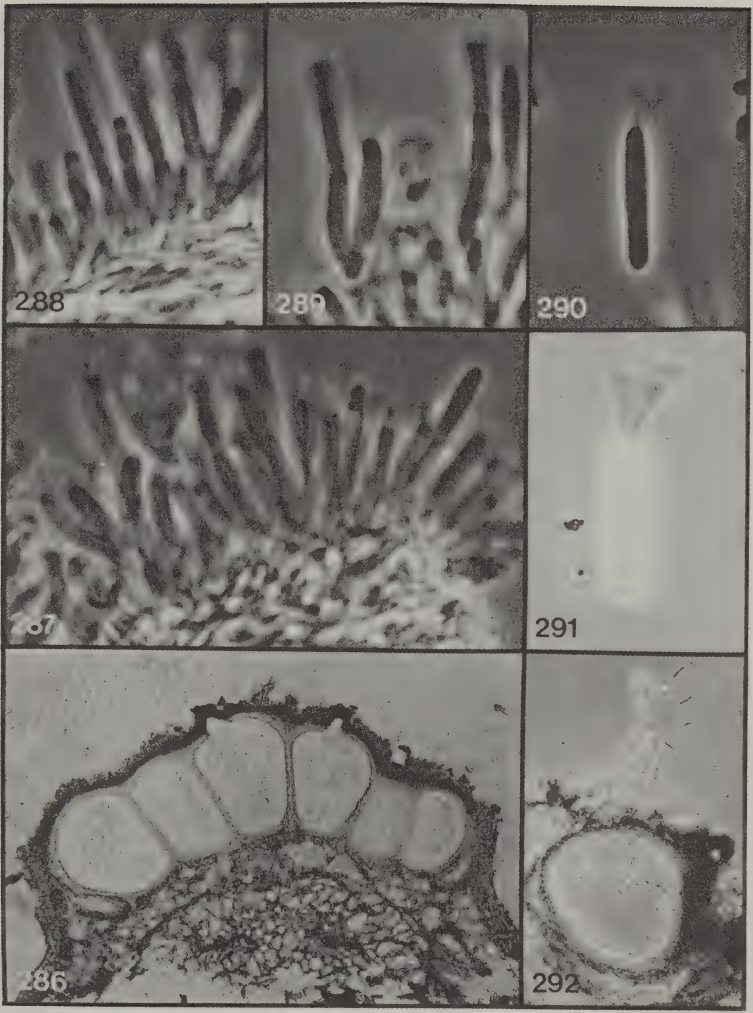
Known distribution: Belgium; England; Finland; France; Germany; Scotland; Switzerland; Sweden; Asia.

Specimens examined: In UPS, ex herb. Fries, original collection of *P. lacerum*, depauperate; in FH, Fuckel Fungi Rhenani 2676; in H, ex herb. P. Karsten, P. Karsten, Finland, 1869-IV-08 (anamorph); in H, P. A. Karsten no. 1585, Finland, 1867-VI-06 (anamorph); in IMI, 223355, D. W. Minter, Rotten of Gairn, Kingswells, Aberdeen, Scotland, 1977-IV-17; IMI 225392, D. W. Minter & G. Skarmoutsos, Brashing, Rotten of Gairn, Kingswells, Aberdeen, Scotland, 1977-V-04; IMI 223389, D. W. Minter, Aberdeenshire, Scotland, 1976-III-28; IMI 223390, D. W. Minter, Kinloch Castle Woods, Isle of Rhum, 1977-VI-04; IMI 225869, D. W. Minter, Theale, Reading 1978-II-26; in NY, Thuemen no. 717, Schroeter, Badenia, 1877-IV; in S, herb. Rehm, Rehm, 1878-X-01; Rehm Ascomyceten 1104, Krieger, Koenigstein, 1894-III; Krieger Fungi saxonici 290, W. Krieger, Koenigstein, 1887-IV-30; herb. Rehm, packet labelled 21/2; Sydow Mycotheca germanica 986, P. Sydow, Brandenburg, Germany, 1911-VII-18; Rabenhorst Fungi Europaei 464, T. Spree, Boekhorst no. (no date); packet labelled Jaczewski, 1904; Libert Plant. Crypt. Arduennae, 70, Fasc. 1 (1830); Fungi suecici, H. Kugelberg, Uppland, Gustavsberg s:n, Betsede, 1891-VI.

Ceuthospora pinastri (Fr.) Hoehn. is recognized as the anamorph of *P. lacerum*.

Ceuthospora pinastri (Fr.) Hoehn. Figs. 286-292.
Mitt. Bot. Inst. Techn. Hochsch. Wien 2: 104 (1925).
≡ *Dothidea pinastri* Fries, Elenchus Fungorum, p. 123 (1828).
≡ *Dothiorella pinastri* (Fr.) Sacc., Syll. Fung. 3: 241 (1884).
≡ *Fusicoccum pinastri* (Fr.), Karst., Hedwigia 23: 22 (1884).

Foliicolous or on cone scales. Conidiomata pycnidial, amphigenous, scattered, gregarious to densely crowded, discrete, subepidermal, raising the epidermis into pulvinate swellings, splitting the overlying host tissue into regular teeth, multilocular, with 10-50 individual locules, scabrous above, 500-1500 µm diam.; rarely unilocular, then 100-200 µm diam.; brown above, pale yellow below, individual locules 120-170 µm diam. and 250 µm tall, bearing individual ostioles up to 25 µm diam., bordered by pale brown *textura globulosa*. Individual pycnidia flask-shaped to irregularly subglobose, of brown *textura globulosa* above, pale yellow *textura porrecta* toward the conidiogenous region and below, 10-15 µm thick in the vertical



Ceuthospora pinastri anam. of *Phacidium lacerum* ex Thuemen 717 in NY. 286. V.S. multilocular conidioma. x 75. 287. Detail of subhymenium and conidiogenous cells. x 1280. 288, 289. Detail of conidiogenous cells. x 1280. 290. Conidium in lactic acid. x 1280. 291. Conidium in distilled water. x 1280. 292. V.S. unilocular conidioma. x 125.

walls separating the individual locules. Conidiophores simple or branched, septate, often reduced to simple conidiogenous cells (phialides) lining the locules, arising from the innermost hyaline cell layer of the conidioma, hyaline, smooth-walled, (5-) 7-15 X 2-3 ($\bar{x}$ = 12.5 X 2.5) µm, invested in mucilage. Conidia blastic-phialidic, non-septate, subcylindrical, bases rounded except for a minute dehiscence scar, tapered slightly toward the apex, hyaline, smooth-walled, 11.5-15 X 2-2.5 (-3) ($\bar{x}$ = 13.5 X 2.5) µm, mean length/width ratio = 5.4:1, invested in a partial mucilaginous sheath which becomes everted at maturity to form an irregular to funnel-shaped, mucilaginous apical appendage.

Habitat: on fallen leaves of Pinus sylvestris and cone scales of P. taeda.

Known distribution: see teleomorph.

Specimens examined: In NY, Thuemen 717, Shroeter, Badenia, 1877-VI (sub Phacidium lacerum, in association with the teleomorph; F. Petrak, 1936-IV-17 (no other data)); in H, ex herb. Karsten no. 1585, P. A. Karsten, Finland, 1867-VI-06; in UT, (University of Texas, Austin) as F. DiCosmo no. 53, J. Loftus & F. DiCosmo, Bueschner State Forest, Smithville, Texas, U.S.A., 1979-II-02.

The nomenclatural history of P. lacerum has already been discussed. This species was recognized as the lectotype species of Phacidium by earlier authors. The problems inherent in this lectotypification have been outlined.

The C. pinastri anamorph of P. lacerum has also had a turbulent history. Fries (1828) first described Dothidea pinastri for a fungus found on fallen leaves of Pinus sylvestris.

Fuckel (1866/1867) appears to have been the first to recognize that D. pinastri was the anamorph of Phacidium lacerum. He provided a short description of the conidia of the anamorph and a more detailed account of the teleomorph. Fuckel suggested that the anamorph showed affinities with the anamorphs of P. cicatricola, P. salicinum Fuckel, and P. vaccinii Fr.

Saccardo (1884) transferred Dothidea pinastri to Dothiorella ('Dothiorella ? pinastri (Fr.) Sacc.') and also suggested that it was the anamorph of Phacidium lacerum, which also occurred on Pinus sylvestris.

Karsten (1884) considered that the conidial fungus was better referred to Fusicoccum pinastri (Fr.) Karst., and agreed that it was the anamorph of Phacidium lacerum. Karsten (1890) repeated these observations.

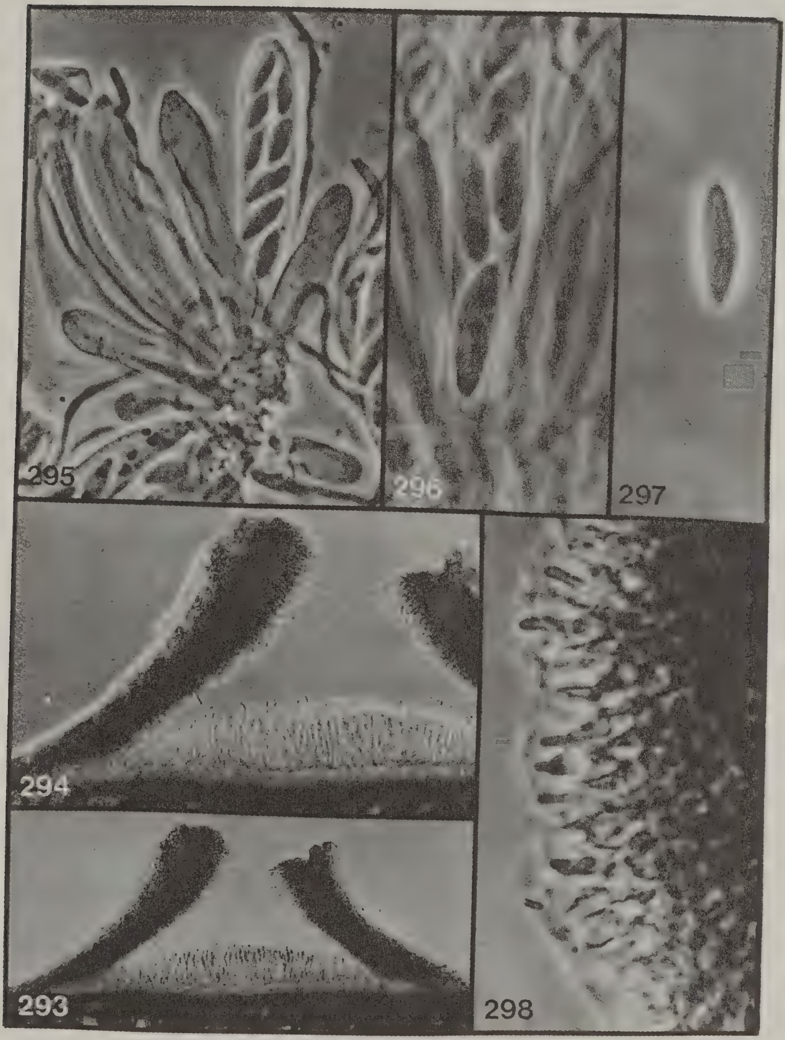
Rehm (1896) provided an updated description of the teleomorph, indicating that the asci had a strongly amyloid dehiscence mechanism, and supported the hypothesis that D. pinastri was the anamorph of P. lacerum.

Hoehnel (1925) recognized that D. pinastri was best referred to Ceuthospora pinastri (Fr.) Hoehn. He, too, noted that the Ceuthospora anamorph was often found with the teleomorph on Pinus sylvestris.

Gremmen (1959, 1960) proved the anamorph-teleomorph connection in pure culture. Gremmen (1960) described the apical mucilaginous appendage found on conidia of C. pinastri, saying: "...conidia are provided at one side with two slender, up to 3 u long colourless appendages." It appears that Gremmen misinterpreted the apical appendage, perhaps by seeing it in optical section.

Phacidium lacerum is usually found on fallen leaves of Pinus sylvestris. Petrak (1924, 1962) reported the fungus on leaves of Abies sp. and Pinus nigra. Gremmen (1960) isolated P. lacerum from dying branches of Pseudotsuga menziesii. He did not state whether the species colonized Pseudotsuga menziesii leaf litter or not. We have found C. pinastri on cone scales of Pinus taeda in Texas.

16. Phacidium lunatum DiCosmo, Nag Raj & Kendrick Figs. 293-298.
Can. J. Botany 61: 38 (1983).



Phacidium lunatum. 293. V.S. of mature ascoma. x 75. 294. Detail of fungal covering layer of ascoma. x 125. 295. Asci and paraphyses. x 770. 296, 297. Ascospores. x 1280. 298. Detail of interior of roof, showing short periphysoids in mucilage. x 1280.

Anamorph: *Apostrasseria* sp.

Foliicolous. Ascomata amphigenous, scattered, gregarious to crowded, usually separate, sometimes confluent, black, circular to irregular, 450-1000 µm diam., initially immersed, intraepidermal to subepidermal, erumpent, rupturing by 3-4 teeth; fungal covering layer of dark brown *textura epidermoidea* becoming a *textura globulosa* toward the interior, 50-100 µm thick above, innermost layer of hyaline, smooth-walled periphysoids, 10-15 X 1.5-2.5 µm, invested in mucilage. Hymenium up to 80 µm thick, composed of asci and paraphyses; subhymenium of hyaline *textura angularis*, 15-20 µm thick; basal stroma of pale brown *textura epidermoidea*, 10-30 µm thick. Asci 8-spored, club-shaped, flat in the region of the amyloid (I^+) apical dehiscence mechanism, 60-70 x 6-8 ($\bar{x}$ = 65 X 6.5) µm. Ascospores biseriate, ellipsoid to fusiform, biguttulate, hyaline, smooth-walled, 8-11 X 3-4 ($\bar{x}$ = 9 X 3.5) µm, mean length/width ratio = 2.5:1. Paraphyses simple or branched, septate, tapered slightly toward the rounded apices, hyaline, 60-80 X 1.5-2 µm, invested in mucilage.

Habitat: on senescent leaves of *Gaultheria procumbens*.

Known distribution: Canada (Ontario); U.S.A. (New York).

Specimens examined: In DAOM 180582, Holotype, F. DiCosmo, Raquette L., N.Y., U.S.A., 1976-IX; in WAT, Isotype, F. DiCosmo, Lookout Tr., Algonquin Pk., Ontario, Canada, 1980-IX-09.

Ascospore inoculations germinated on readily on PDA, but produced no anamorph after repeated transfer and 10 months at 20°C. However, after the culture was cooled to 5°C for 48 hrs, an *Apostrasseria* anamorph developed in 6 days.

Conidiomata of this anamorph were abundant in close association with the teleomorph on the host. The anamorph is identical to what was called *Ceuthospora lunata* Shear (Shear 1907), which is referable to *Apostrasseria*.

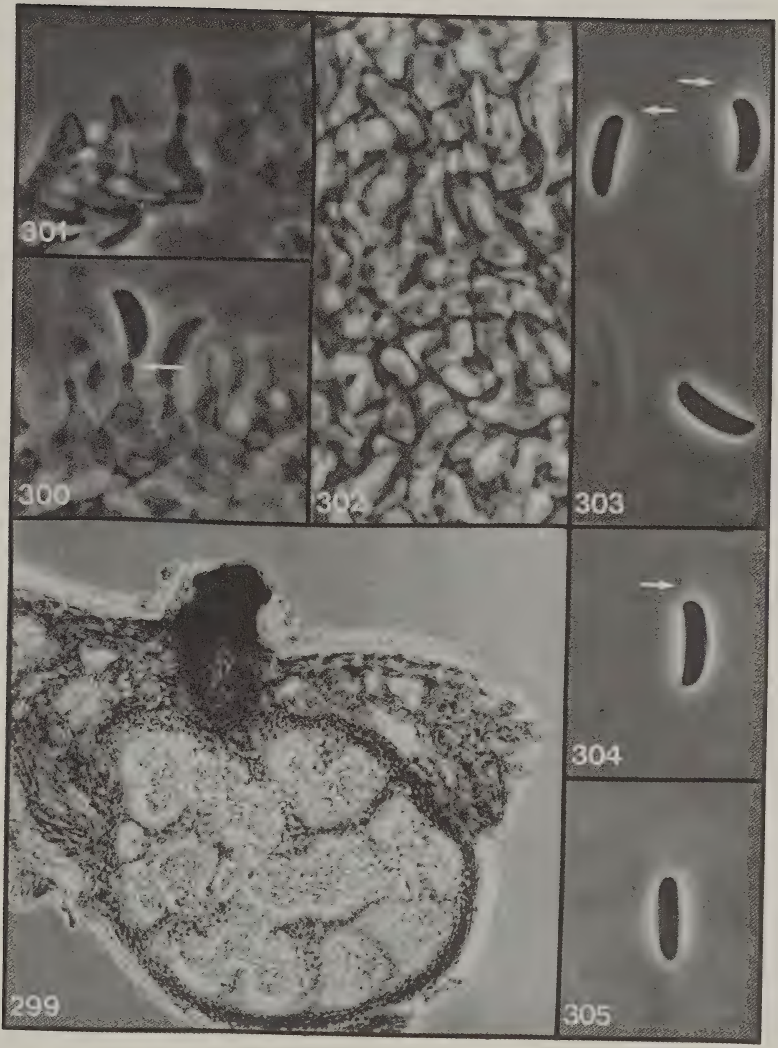
Apostrasseria lunata (Shear) Nag Raj anamorph of *Phacidium lunatum*. Figs. 299-305.
Can. J. Botany 61: 19 (1983).

Caulicolous. Conidiomata pycnidial, epiphyllous, scattered to gregarious, marked by minute, circular, straw-coloured necrotic spots, with a protuberant neck, immersed, subepidermal, globose to depressed globose, multilocular, brown, 200-500 µm diam., with a papillate neck, ostiolate; wall of pale brown to brown *textura prismatica* up to 10 µm thick below, hyaline toward the hymenium, of brown *textura globulosa* at the neck; individual locules separated by hyaline walls of *textura porrecta* (hyphae with gelatinizing outer walls). Conidiogenous cells phialides, lining the locules, subulate, ampulliform to lageniform, hyaline, smooth-walled, 5-10 X 3-5 ($\bar{x}$ = 7 X 3.5) µm below, 0.5-1.0 µm wide above, invested in mucilage. Conidia blastic-phialidic, sublunate to reniform in side view, oblong-ellipsoid in face view, apex rounded, base slightly tapered and truncate, biguttulate, hyaline, smooth-walled, 6-9 X 2-3 ($\bar{x}$ = 7.5 X 2.5) µm, mean length/width ratio = 3:1, bearing an irregular, apical, mucilaginous appendage.

Habitat: on leaves of *Gaylussacia brachycera*, *Gaultheria procumbens*, and *Vaccinium macrocarpum*.

Known distribution: Canada (Ontario); U.S.A. (Maryland, Massachusetts, New Jersey, New York).

Specimens examined: In WAT, F. DiCosmo, Raquette L., N.Y., U.S.A., 1976-IX; DAOM 180582, Holotype of *P. lunatus*; in WAT, F. DiCosmo, Lookout Tr., Algonquin Pk., Ontario, Canada, 1980-IX-09; In NY, (ex BPI 60728), Diehl, Pasadena, MD, U.S.A., 1926-XI-06 (authenticated by C. L. Shear); IMI 92417 (collection data as above).



Apostrasseria lunata anam. of *Phacidium lunatum*. 299. V.S. multiloculate conidioma. x 205. 300, 301. Conidiogenous cells with developing conidia, arrow indicates collarette. x 1280. 302. Detail of exterior *textura epidermoidea* of conidioma. x 1280. 303, 304. Conidia, arrows indicate apical mucilaginous appendages. x 1280. 305. Mature conidium in face view. x 1280.

The Ontario and New York collections were found on dead leaves still attached to the parent plant, or on the ground. The name Ceuthospora lunata Shear was introduced by Shear (1907) for an anamorphic fungus found on leaves of Vaccinium macrocarpum. Shear was not aware of the relationship of this anamorph to Phacidium. His disposition of the fungus was tentative. Characteristics discussed in the present study have shown that although allied to Ceuthospora, this anamorph is better maintained in Apostrasseria.

17. Phacidium multivalve (DC.:Fr.) Schm. Figs. 306-311.
in Kunze & Schmidt, Mycol. Hefte p. 42 (1817).
≡ Xyloma multivalve DC., Flor. France, 2: 303 (1815).
≡ Phacidium multivalve (DC.) Schm., in Kunze & Schmidt, (1817).
≡ Phacidiostroma multivalve (DC.) Hoehn., Annls. Mycol. 15: 325 (1917).
= Phacidium ilicis Libert, Plant. Crypt. Ard. Fasc. IV, no. 367 (1837).

Foliicolous. Ascomata amphigenous, scattered to gregarious, discrete, oval to subcircular in outline, black, up to 2000 µm diam., initially immersed, subcuticular, stroma extending deeply into mesophyll, often occupying entire thickness of leaf, producing irregular swellings, ultimately splitting irregularly by 3-6 teeth to expose the hymenium; fungal roof composed of dark brown to red-brown outer stromatic tissue becoming brown textura globulosa toward the interior, up to 250 µm thick at the apex, innermost layer of simple hyaline, smooth-walled periphysoids which are embedded in mucilage. Immersed sclerotioid tissue composed of black to dark brown, outer pseudoparenchymatous cells forming a compact textura globulosa which becomes pale brown to subhyaline toward the interior, 90 um thick; subhymenium of hyaline textura globulosa 15-20 µm thick, merging with the sclerotioid tissue. Asci club-shaped, 8-spored, flattened in the region ofthe amyloid (I^+) apical dehiscence mechanism, 80-90 X 7-9 ($\bar{x}$ = 86 X 8.5) µm. Ascospores uniseriate, ellipsoid to irregular ellipsoid, hyaline, smooth-walled, 9-11 X 3.5-5 ($\bar{x}$ = 10 X 4) µm, mean length/width ratio = 2.5:1. Paraphyses usually simple, flexuous, subcylindrical, septate, up to 90 X 1.5-2.5 µm, invested in mucilage.

Habitat: on leaves of Ilex aquifolium and Rhododendron baetici.

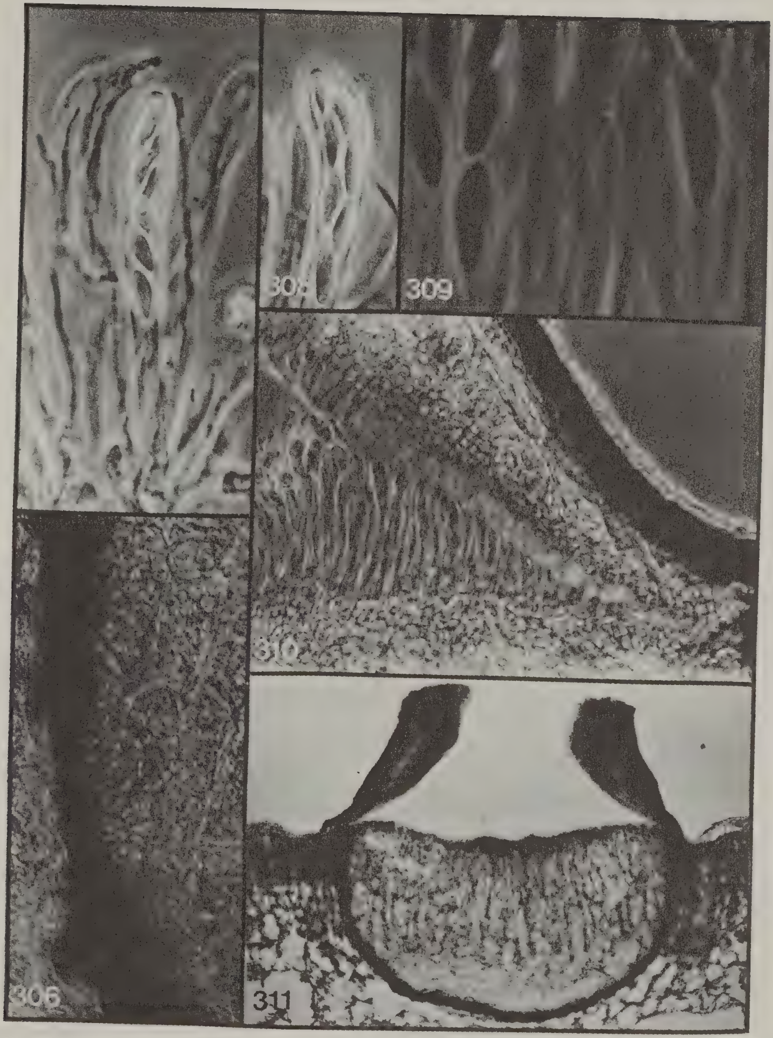
Known distribution: Belgium; England; France; Germany; Portugal; Spain (teste Unamuno 1941).

Specimens examined: In G, Lectotype, DeCandolle; in S, Torrend no. 321, Portugal (no date); in NY, C. Roumeguère Fungi Selecti exsiccati no. 37 ex Reliquiae Mougeotianae.

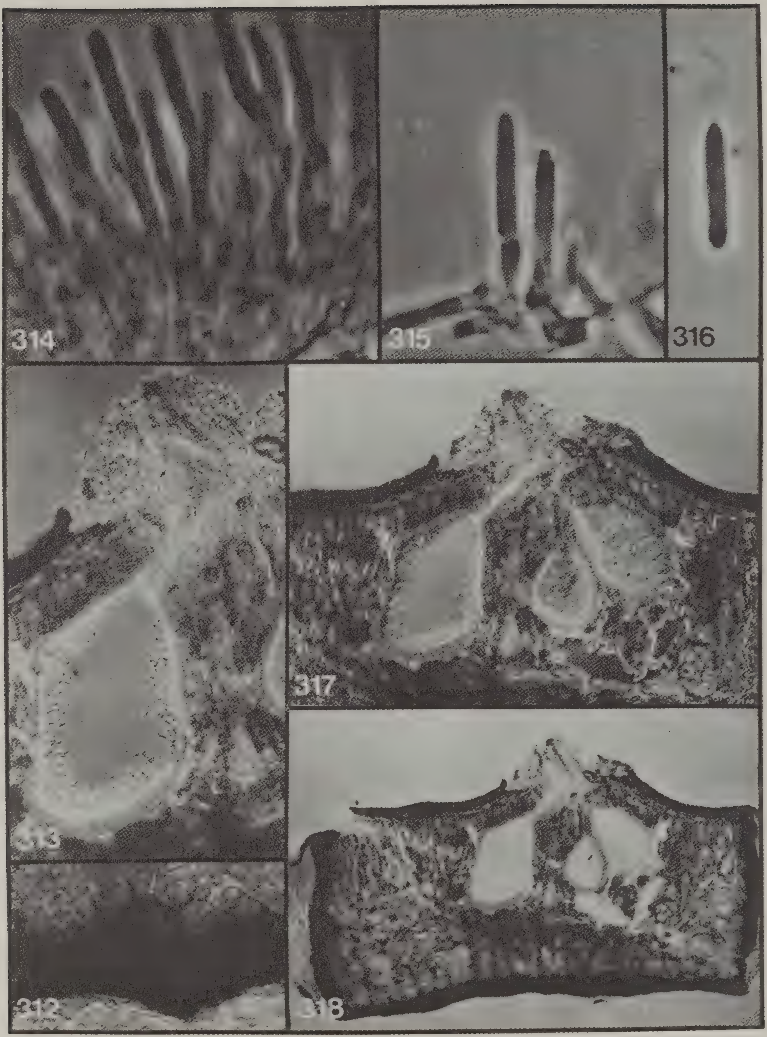
The presumed anamorph of P. multivalve is Ceuthospora phacidioides Grev.

Ceuthospora phacidioides Grev.:Fr., Scot. Crypt. Flor. 5: 253 (1827). Figs. 312-318.
= Sphaeria bifrons Sowerby
English Fungi 3 (1803).
= Ascochyta aquifolii Lib., Plant. Crypt. Ard. Exs. Fasc. IV, no. 351 (1837).

Foliicolous or caulicolous. Conidiomata stromatic, pycnidial, amphigenous when foliicolous, scattered to gregarious, discrete, oval to subcircular in outline, shining black, up to 2000 µm in diam., composed of 3-10 individual pycnidial locules embedded in a pseudoparenchymatous, sclerotioid tissue composed of dark red-brown to black outer cells forming a textura globulosa which becomes pale brown to subhyaline toward the



Phacidium multivalve ex Torrend 321 in S. 306. Detail of basal sclerotioid tissue. x 770. 307. Ascus and paraphyses. x 770. 308. Ascus with biseriate ascospore arrangement. x 770. 309. Ascospore morphology. x 1280. 310. Detail of subhymenium, roof, and periphysoids in mucilaginous matrix. x 310. 311. V.S. conidioma with basal sclerotioid tissue, enclosed by a carbonaceous integument. x 310.



Ceuthospora phacidioides anam. of *Phacidium multivalve* ex Torrend 321 in S. 312. Detail of integument of basal tissue. x 770. 313. Locule with ostiolar region. x 310. 314, 315. Conidiogenous cells with developing conidia. x 1280. 316. Mature conidium. x 1280. 317. Apical region of multiloculate conidioma. x 75. 318. V.S. conidioma: note basal sclerotioid tissue and carbonaceous integument. x 50.

interior, up to 600 µm thick; pycnidial locules with a raised common area of dehiscence, marked by a pale-yellow to white furfuraceous border; initially immersed, subcuticular, extending into the host tissue, stroma (when caulicolous) occupying entire thickness of leaf; locules developing within the fungal tissue, subglobose to globose, 130-200 µm diam., composed of pale yellow to subhyaline *textura oblita* up to 15 µm thick, becoming hyaline toward the hymenium; individual pycnidia with necks, ostiolate; conidiophores arising from the innermost, hyaline cells of the conidioma, branched or simple, septate, hyaline, smooth-walled, 10-25 X 2-2.5 µm, invested in mucilage. Conidiogenous cells phialides, simple or integrated, subcylindrical, hyaline, smooth-walled, 5-12.5 X 2-2.5 ($\bar{x}$ = 9.5 X 2) µm. Conidia blastic-phialidic, non-septate, subcylindrical, tapering slightly toward the apex and bearing a minute dehiscence scar at the base, hyaline, smooth-walled, 10-17 X 2.5 (-3) ($\bar{x}$ = 14 X 2.5) µm, mean length/width ratio = 5.6:1, invested in a mucilaginous sheath which becomes everted at maturity to form an irregular to funnel-shaped, mucilaginous apical appendage.

Habitat: on leaves of *Ilex aquifolium* and *Rhododendron baetici*.

Known distribution: see teleomorph.

Specimens examined: In G, Lectotype of *Phacidium multivalve*; in NY, Rabenhorst-Winter Fungi Europaei no. 2799, Letendre, St. Jouim, France; C. Roumeguère, Fungi Selecti Gallici Exsiccati no. 37 ex Reliquiae Mougeotianae; G. D. Westendrop & A. C. F. Wallays no. 527, Bellynck, Namur, Belgium; M. C. Cooke, Fungi Britannici Exs. no. 158, Highgate, London, 1865-I (immature stromata only); M. C. Cooke, British Fungi no. 2534; Ellis herb. no. 1104, Bloxam, England; Desm., Plant. Crypt. France no. 571; in S, Torrend no. 321, Portugal (no date).

Schmidt, in Kunze & Schmidt (1817), introduced *Xyloma multivalve* to *Phacidium*, and gave a description, but nomeasurements.

Fries (1823) accepted *P. multivalve*, so is credited with providing the sanctioned combination in *Phacidium*.

Tulasne & Tulasne (1865) found that the anamorph was common, the teleomorph less so. They provided a nomenclatural resume, and cited synonyms for both anamorph and teleomorph. The Tulasnes adopted *P. ilicis* as the correct name for the fungus and cited *P. multivalve* as a synonym. This is untenable because *P. multivalve* was validated 16 years before *P. ilicis*. A meagre description of the teleomorph was given, but a more detailed description of the *Ceuthospora phacidioides* anamorph was provided. Tulasne & Tulasne (1865) had "...no hesitation in considering *Phacidium ilicis* Lib. to be a fungus that has two forms."

Rehm (1896) accepted *P. multivalve* with *C. phacidioides* as its anamorph.

Hoehnel (1917a) found that the stroma produced by *P. multivalve* occupied the entire thickness of the host leaf. On that basis, Hoehnel erected *Phacidiostroma* Hoehn., based on *P. multivalve* (DC.:St. Amans). Hoehn. Later, Hoehnel (1917b) established the Phacidiostromataceae to accommodate *Phacidiostroma*.

Hoehnel (1925) accepted *C. phacidioides* as the anamorph of *P. multivalve*, but provided no clarifying measurements of important features. However, a description of the genus *Ceuthospora* Greville was provided.

Terrier (1942) provided a detailed description of *P. multivalve*, and suggested that *P. multivalve* could perhaps be accommodated in *Phacidium* because both the teleomorphs and anamorphs of known *Phacidium* spp. were similar to *Phacidiostroma multivalve* and its anamorph. However, Terrier accepted *P. multivalve sensu* Hoehnel and maintained *Phacidiostroma* in the Phacidiaceae *sensu* Terrier.

Dennis (1968, 1978) provided a description of *Phacidiostroma multivalve* and noted that most authors called the species *Phacidium multivalve*.

18. *Phacidium pini-cembrae* (Rehm) Terrier Figs. 319-324.
Beitr. zur Kryptogamen flora der Schweiz 9: 73-74 (1942).
≡ *P. lacerum* Fr.:Fr. f. *pini-cembrae* Rehm, Ber. Bayr. Bot. Ges. 13: 124 (1912).

Foliicolous. Ascomata on the convex face of leaves, scattered, gregarious, often becoming confluent, subcircular to ellipsoid, up to 1000 µm long and 600 um wide, usually on either side of the centre, subepidermal, raising the overlying host tissue into orbicular swellings, then splitting by 4-5 irregular teeth of brown outer *textura globulosa*, light brown toward the interior, innermost layer of hyaline periphysoids, composed of 2-3 cells up to 21 X 3.5 µm, with rounded apices. Hymenium plane, pale yellow-brown, up to 112 µm thick; subhymenium of densely crowded, branched, septate, hyaline, smooth-walled hyphae forming a *textura angularis* up to 50 µm thick. Asci club-shaped, 8-spored, tapered slightly toward the apices and flattened in the region of the amyloid (I^{+}) dehiscence mechanism, 95-112 X 12-15 ($\bar{x}$ = 103 X 13.5) µm. Ascospores biseriate, elongate-ellipsoid, straight or slightly curved to fusiform, non-septate, guttulate, hyaline, smooth-walled, 13-23 X 5.5-7 ($\bar{x}$ = 18 X 6) µm, mean length/width ratio = 3:1. Paraphyses usually simple, septate, hyaline, smooth-walled, flexuous, up to 112 X 1.5 µm.

Habitat: on leaves of *Pinus cembra*, *P. sibirica teste* Millar & Minter (1980), and *Pseudotsuga menziesii* (in DAOM 71622).

Known distribution: Austria; Canada (British Columbia); Italy; Switzerland; U.S.S.R.

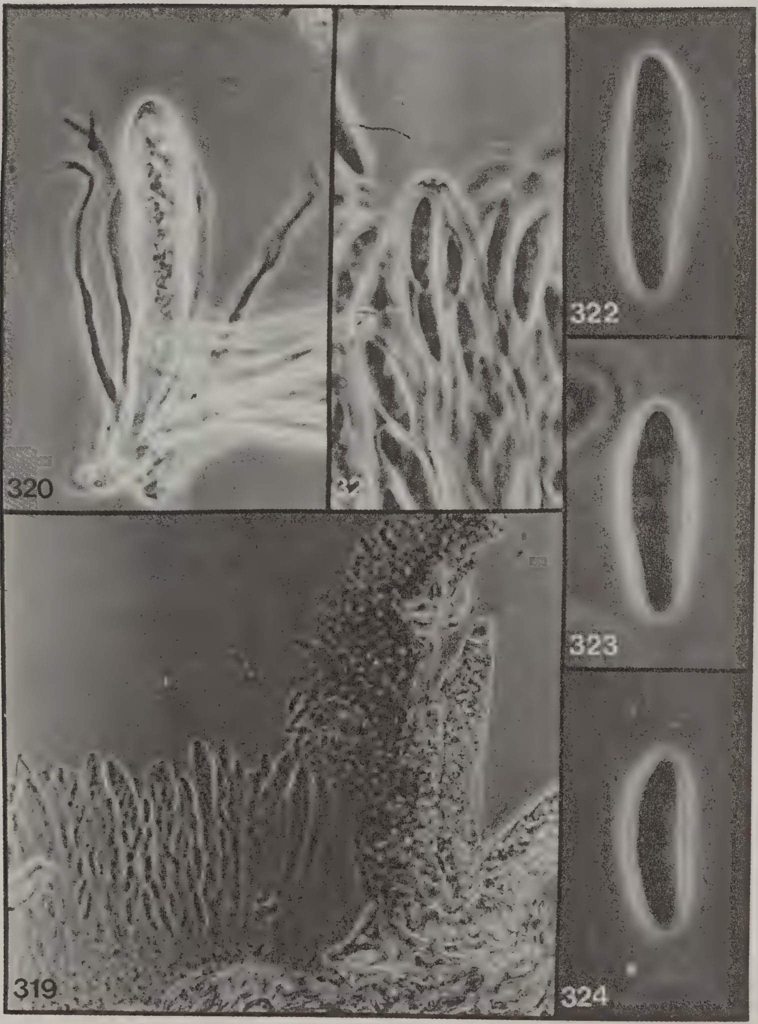
Specimens examined: In DAOM 91829 ex Botanische Sammlungen der Eidg. Techn. Hochsch., Zurich, Ch. Brodbech, Switzerland, 1931-VIII; DAOM 91681, E. Mueller & R. A. Shoemaker, near Berguen, Graubuenden, Switzerland, 1961-VIII-22; DAOM 71622 ex DAVFP 11776, E. G. Harvey, Peachland, British Columbia, Canada, 1959-III-11; in IMI 94256, O. Wettstein, Austria, 1955-IX-01; IMI 94539, O. Wettstein, 1800m, Austria, 1955-IX-01; in Z, C. Brodbeck, Evolena, 1800-220m, 1931-VIII; C. Terrier, Statzerwald, Switzerland, 1935-VII-23; C. Terrier, Graubuenden, Val Bernina, betw. Pontresina and Morteratsch, 1938-VII-17; C. Terrier, Graubuenden, Celerina, path from Cristolais to Alp Clavadatsch, Switzerland, 1938-VII-05; Terrier, Wallis, Zermatt, Switzerland, 1938-VII-30; Valais, Rd. from Zermatt to Staffelalp, Switzerland, 1938-X-22; Valais, betw. Zeneggen and Moosalp, ca. 1870m, Switzerland, 1938-VII-05; C. Terrier, Albulatal, Piz Palpuogna, ca. 2170 m, 1937-VIII-05.

Terrier (1942) described *P. pini-cembrae* and provided a brief discussion of the biology of the species. He was able to distinguish *P. pini-cembrae* from the very similar *P. infestans* (q.v.).

Millar & Minter (1980) have provided a modern description of *P. pini-cembrae* and noted that the species was confined to Europe. During our studies of *P. infestans* in DAOM, a collection (DAOM 71622 from British Columbia, Canada) of the fungus on *Pseudotsuga menziesii* was found. In our opinion that collection is best referred to *P. pini-cembrae*, and represents the first report of that species in North America. DAOM 71622 also represents the first report of *P. pini-cembrae* on a host other than a 5-needled species of *Pinus*.

P. pini-cembrae and *P. infestans* are usually confused, and cultural and pathogenicity studies of these two species are urgently needed in order to clarify their relationship. The fungus on *Pseudotsuga menziesii* also needs further investigation.

19. *Phacidium pusillum* Libert. Figs. 325-328.
Plant. Crypt. Arduennae Fasc. 3 no. 268 (1834).
≡ *Cryptodiscus pusillus* (Lib.) Rehm, Hedwigia 30: 252 (1891).



Phacidium pini-cembrae ex DAOM 91681. 319. V.S. ascoma. x 205. 320. Ascus and paraphyses. x 770. 321. Apical part of an ascus, showing amyloid dehiscence mechanism. x 1280. 322-324. Ascospores. x 1280.

Caulicolous. Ascomata scattered to gregarious, discrete, initially immersed, subcuticular, producing irregular swellings, 500-650 µm diam., ultimately splitting open irregularly by 3-5 teeth to expose the hymenium; the fungal roof is of brown pseudoparenchymatous cells forming a *textura globulosa* which is pale brown toward the interior; innermost layer of smooth-walled periphysoids with gelatinizing outer walls, invested in mucilage. Hymenium plane, up to 70 µm thick, of asci and paraphyses; subhymenium of densely crowded cells forming a *textura angularis* up to 13 µm thick; basal stroma of brown *textura globulosa* up to 15 µm thick. Asci club-shaped, 8-spored, with an amyloid (I^+) dehiscence ring, 50-70 X 7-9 ($\bar{x}$ = 62 X 8.5) µm. Ascospores biseriate, ellipsoid to irregular-ellipsoid, non-septate, hyaline, smooth-walled, 7.5-12.5 x 2.5-4 ($\bar{x}$ = 11 X 3.5) µm, mean length/width ratio = 3.1:1. Paraphyses simple, septate, hyaline, smooth-walled, flexuous, up to 70 X 1.5-2 µm, invested in mucilage.

Habitat: on dried stems of *Rubus fruticosus*.

Known distribution: Germany.

Specimens examined: In FH, Isotype, ex Libert Plant. Crypt. Arduennae Fasc. 3, no. 268 (1834); in S, *ibid*.

We found conidiomata of the presumed *Apostrasseria* anamorph of *P. pusillum* growing in close association with the teleomorph.

Apostrasseria anamorph of *P. pusillum*. Figs. 329-334.

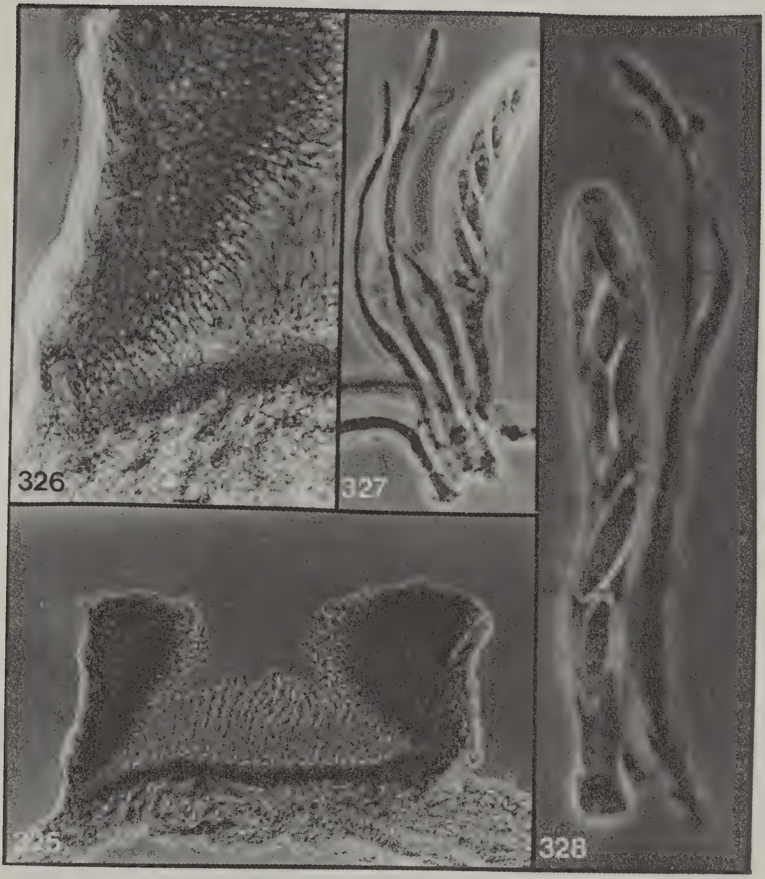
Caulicolous. Conidiomata pycnidial, scattered to gregarious, often crowded, discrete, initially immersed, subepidermal, raising the overlying tissue into straw-coloured swellings; globose to depressed-globose, brown above, pale-brown below, multilocular, 230-300 µm diam., and 180-250 µm tall, ostiole up to 30 µm diam.; wall pseudoparenchymatous, of *textura globulosa*. Conidiophores arising from the innermost, hyaline cells of the locules, branched or simple, septate, hyaline, smooth-walled, 10-20 X 3-5 ($\bar{x}$ = 15 X 4) µm, invested in mucilage. Conidiogenous cells phialides, simple or integrated irregularly, lageniform to ampulliform, proliferating percurrently 1-3 times, hyaline, smooth-walled, 6-11 X 2.5-5 ($\bar{x}$ = 8.5 X 3.5) µm. Conidia blastic-phialidic, reniform to lunate, apices rounded and with an inconspicuous truncate base, hyaline, smooth-walled, 6-8 X 2-2.5 ($\bar{x}$ = 7 X 2.5) µm, mean length/width ratio = 2.8:1, bearing an irregular, apical, mucilaginous appendage.

Habitat: see teleomorph.

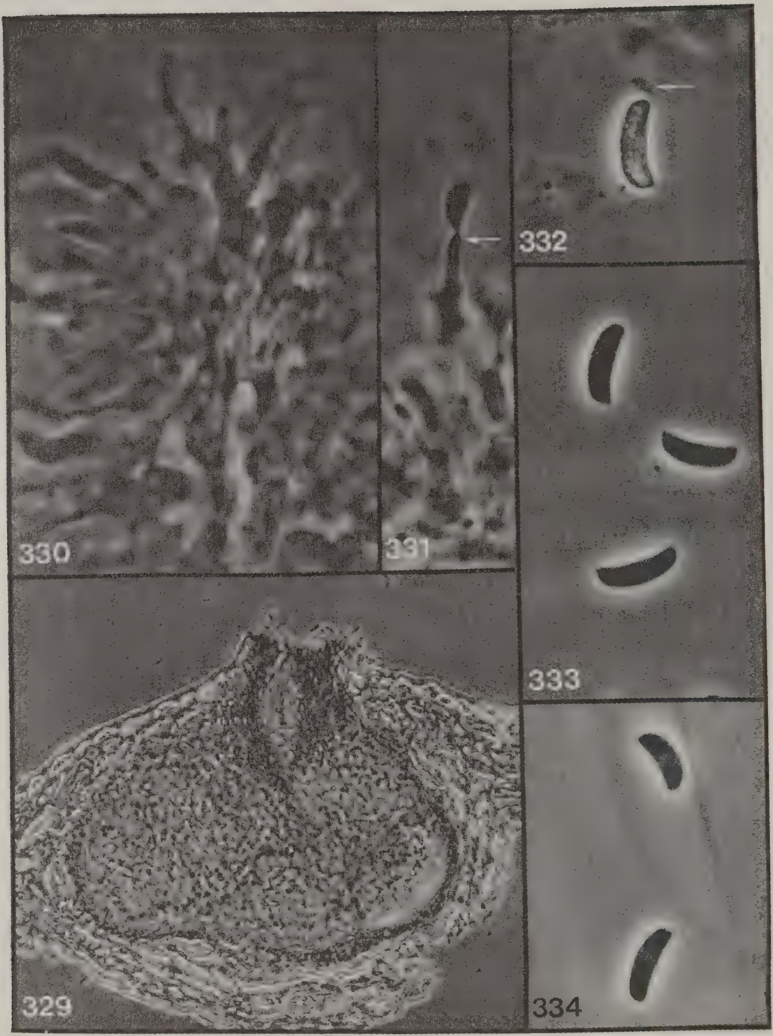
Libert (Plant. Crypt. Ard. Fasc. 3, no. 268, 1834) issued *P. pusillum* for a fungus found on dead, dry stems of *Rubus fruticosus*. The description on the exsiccatum from FH did not mention the microanatomy of *P. pusillum*, nor was the presence of an anamorph indicated.

Rehm (1896) provided a description of *Cryptodiscus pusillus* (Libert) Rehm (≡ *P. pusillum*). However, Rehm's observations were not based on authentic or type material. Rehm found that Brefeld (1891) had studied the species in culture and described the conidia. Brefeld's observations were made on *Cryptodiscus caeruleo-viridis* Rehm, a species considered referable to *P. pusillum* by Rehm (1896). The description provided by Brefeld for the anamorph of *C. caeruleo-viridis* does not fit the *Apostrasseria* anamorph of *P. pusillum*. We believe Brefeld actually studied a fungus not congeneric with any *Phacidium*, nor even a member of the Phacidiaceae *sensu* DiCosmo, Nag Raj & Kendrick.

Hoehnel (1918) provided a good description and taxonomic history of *P. pusillum*, and placed it in *Phacidium sensu stricto*.



Phacidium pusillum. 325. V.S. mature ascoma. x 125. 326. Detail of margin of ascoma illustrating tissue types. x 310. 327. Portion of subhymenium, showing paraphyses in mucilaginous matrix, and ascus with biseriate ascospores. x 770. 328. Ascus and ascospores. x 1280.



Apostrasseria anam. of *Phacidium pusillum*. 329. V.S. multilocular conidioma. x 205. 330. Conidiophores and conidiogenous cells. x 1280. 331. Conidiogenous cell with percurrent proliferation (arrow). x 1280. 332. Conidium in distilled water: arrow indicates appendage x 1280. 333, 334. Mature conidia in lactic acid: appendages not visible. x 1280.

20. *Phacidium salicinum* Fuckel Figs. 335-338.

Jahrb. Nass. Ver. Nat. 25/26: 328 (1871/1872).

Caulicolous and lignicolous. Ascomata scattered to gregarious, initially immersed, subepidermal, circular to subcircular in outline, up to 1000 µm diam., raising the overlying host tissue into irregular swellings then splitting stellately into 4-6 irregular teeth; fungal roof of brown *textura globulosa*; innermost layer of thin-walled, hyaline, smooth-walled periphysoids which taper to a rounded apex, up to 13 X 2-2.5 µm, invested in mucilage. Hymenium plane, pale grey, of asci and paraphyses, up to 105 µm thick; subhymenium up to 13 µm thick, hyaline; basal stroma brown, of closely packed, septate hyphae forming a *textura epidermoidea* up to 30 µm thick. Asci club-shaped,8-spored, 69-105 X 7-9 ($\bar{x}$ = 150 X 8) µm, with an amyloid (I$^+$) apical dehiscence mechanism. Ascospores ellipsoid, hyaline, smooth-walled, 9-15 X 2.5-4 ($\bar{x}$ = 12 X 3) µm, mean length/width ratio = 4:1. Paraphyses subcylindrical, usually simple, septate, hyaline, smooth-walled, up to 105 X 1-1.5 µm, with slightly swollen, rounded apices, invested in mucilage.

Habitat: on twigs of *Salix caprea*.

Known distribution: Austria.

Specimens examined: In FH, Isotype, Herbier Barbey-Boissier no. 1034 ex Fuckel Fungi Rhenani 2366, L. Fuckel, Austria, 1894; *ibid* in S.

Hoehnel (1925) found that *P. salicinum* was closely associated with its presumed anamorph, *Ceuthospora salicina* Hoehn.

Ceuthospora salicina Hoehn. anamorph of *Phacidium salicinum*. Figs. 339-347.

Hoehnel, Mitt. Bot. Inst. Techn. Hoch. Wien 2: 103 (1925).

Caulicolous and lignicolous. Conidiomata stromatic, pycnidial, scattered to gregarious, often confluent, initially immersed, ultimately raising the overlying host tissue into subcircular, pulvinate swellings, splitting the overlying tissue and becoming erumpent; multilocular, dark brown to black above, pale yellow below, 450-700 µm diam., with up to 12 locules; individual locules variable, up to 200 µm tall, 75-200 µm diam., bearing individual papillate ostioles up to 15 µm long; wall pseudoparenchymatous, of dark brown to black outer *textura globulosa* to *textura prismatica*, pale yellow *textura epidermoidea* toward the hymenium and below. Conidiophores branched or simple, septate, arising from the innermost, hyaline cells of the locules, 10-15 X 2.5-3 µm, invested in mucilage. Conidiogenous cells phialides, subcylindrical, 5-10 X 2.5 ($\bar{x}$ = 8 X 2.5) µm. Conidia blastic-phialidic, subcylindrical, tapered slightly above, hyaline, smooth-walled, 13-17 X 2-2.5 ($\bar{x}$ = 15 X 2.5) µm, mean length/width ratio = 6:1, invested in a partial mucilaginous sheath which everts at maturity to form an irregularly funnel-shaped, apical mucilaginous appendage.

Habitat: see teleomorph.

Known distribution: see teleomorph.

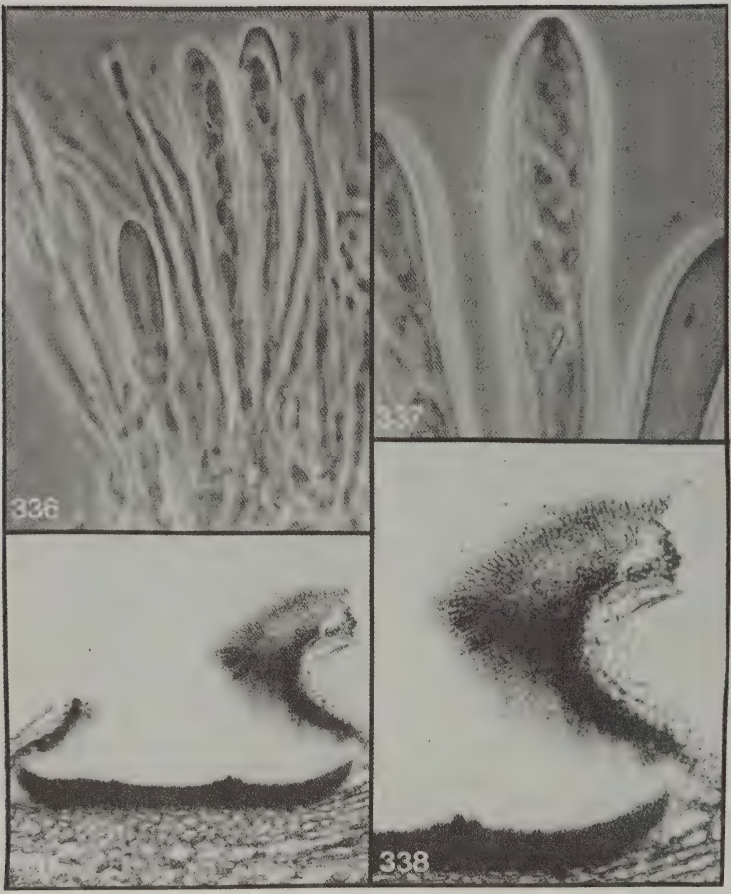
Fuckel (1871/1872) introduced *P. salicinum* for a fungus found on the cortex of *Salix caprea*. He also described the unnamed, presumed anamorph. Fuckel observed that the anamorph was congeneric with the anamorph of *P. vaccinii* Fries (Fries 1823).

Hoehnel (1925) studied the genus *Ceuthospora* and found that the anamorph of *P. salicinum* was *Ceuthospora salicina*.

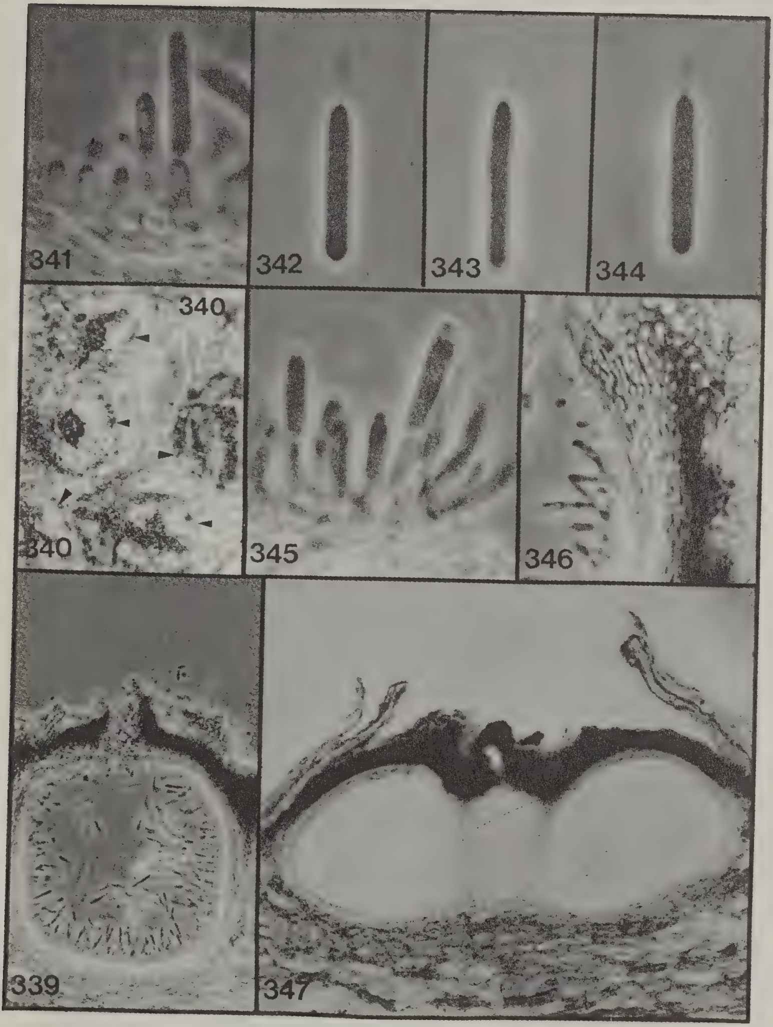
21. *Phacidium sherwoodiae* DiCosmo, Nag Raj & Kendrick Figs. 348-353.

Can. J. Botany 61: 42 (1983).

Foliicolous. Ascomata amphigenous, scattered to gregarious, often confluent, initially immersed, subcuticular to subepidermal, raising host



Phacidium salicinum. 335. V.S. ascoma. x 75. 336. Asci, ascospores and septate paraphyses. x 770. 337. Detail of upper portion of an ascus. x 1280. 338. Detail of margin, covering layer and basal stroma. x 130.



Ceuthospora salicina anam. of *Phacidium salicinum*. 339. Locule of the compound conidioma. x 190. 340. Habit, arrow-heads denote the erumpent conidiomata. x 14. 341. Conidigenous cells. x 1280. 342-344. Conidia: note the apical appendages. x 1280. 345. Conidiogenous cells and developing conidia. x 1280. 346. Detail of hymenium, subhymenium and outer wall of conidioma. x 310. 347. V.S. multiloculate conidioma. x 130.

tissues into subconical swellings, 400-1000 µm diam., central area bordered by pale yellow-brown, furfuraceous cells, fungal covering layer with a central mass of black to dark brown *textura globulosa* up to 70 µm thick, innermost layer of periphysoids, 10-20 X 2-3 µm, invested in mucilage. Hymenium plane, up to 90 µm thick; subhymenium of subhyaline to pale yellow *textura angularis* 5-10 µm thick; basal stroma of pale brown *textura epidermoidea* 5-10 µm thick. Asci club-shaped, 8-spored, 60-90 X 6-8 ($\bar{x}$ = 75 X 7) µm, flattened in the region of the amyloid (I^+) apical dehiscence mechanism. Ascospores uniseriate or biseriate, irregularly ellipsoid to subfusiform, non-septate, hyaline, smooth-walled, 9-11 X 3 (-4) ($\bar{x}$ = 10 X 3) µm, mean length/width ratio = 3.3:1. Paraphyses usually simple, septate, hyaline, smooth-walled, 70-85 X 1.5-2 µm, invested in mucilage.

Habitat: on dead leaves of *Gaultheria shallon* (teleomorph & anamorph), and on dead leaves of *Thuja plicata* (anamorph only).

Known distribution: U.S.A. (Oregon).

Specimens examined: In DAOM 180583, Holotype, M. A. Sherwood no. 418-A, H. J. Andrews Expt. For. Watershed 10, Oregon, U.S.A., 1972-IV-21; Isotype in WAT; in WAT, Sherwood no. 418, (location as above), 1971-IV-21; in WAT, anamorph only, J. Bieraugel, H. J. Andrews Expt. For., Lane Co., Oregon, U.S.A., 1970-VI-08.

Conidiomata of a species of *Ceuthospora* were found in close association with the teleomorph. We presume that the *Ceuthospora* represents the anamorph of *P. sherwoodiae*, although this is only a tentative disposition.

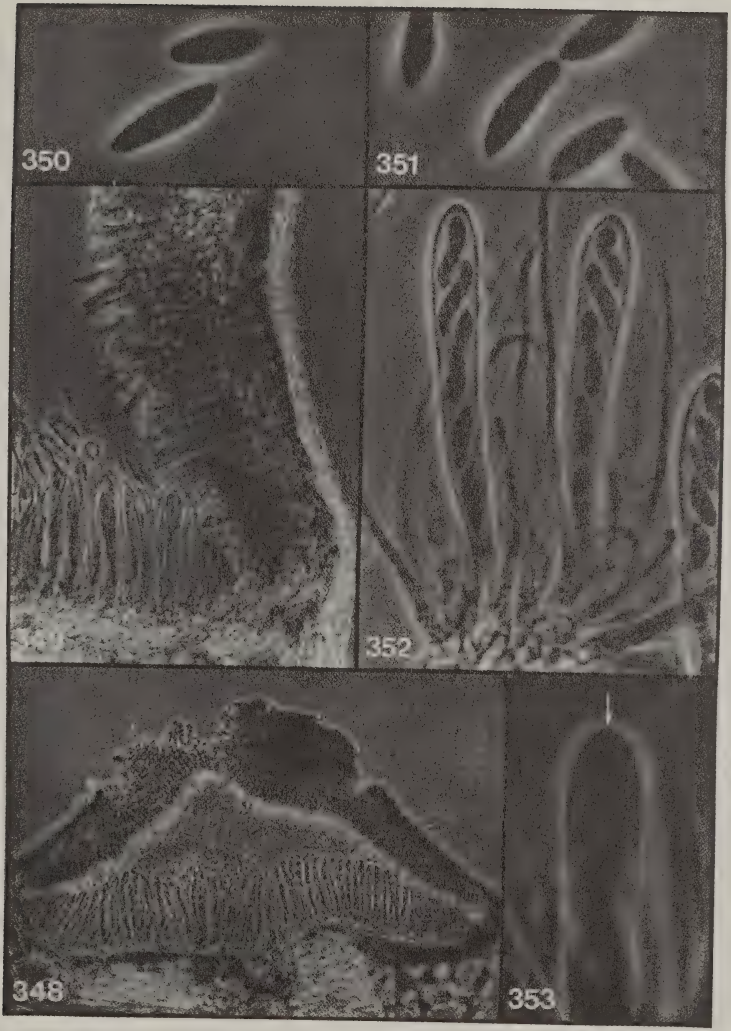
Ceuthospora anamorph of *Phacidium sherwoodiae*. Figs. 354-358.

Foliicolous. Conidiomata pycnidial, scattered to gregarious, shortly stipitate base remaining immersed, subepidermal, dark brown to black, irregularly pulvinate to subspherical, irregularly multiloculate, ostiolate, 500-1500 µm diam., individual locules globose, subglobose to flask-shaped, up to 200 µm diam.; outer wall 20-30 µm thick, of black to dark brown carbonaceous cells forming a *textura globulosa*, ultimately forming a hyaline *textura oblita* toward the hymenium; individual locules separated by a subhyaline to pale yellow-brown wall of *textura oblita*, 15-35 µm thick. Conidiophores arising all around the locules, branched, rarely simple, septate, hyaline, smooth-walled, 15-30 X (2-) 2.5 ($\bar{x}$ = 22 X 2.5) µm, invested in mucilage. Conidiogenous cells phialides with a minute flaring collarette, somtimes proliferating percurrently 1-2 times, subcylindrical, slightly tapered above, hyaline, smooth-walled, 5-12 X (2-) 2.5 ($\bar{x}$ = 8 X 2.5) µm, invested in mucilage. Conidia blastic-phialidic, subcylindrical, tapered above, base rounded except for a minute dehiscence scar, hyaline, smooth-walled, 7.5-11 X (2-) 2.5 ($\bar{x}$ = 9 X 2.5) µm, mean length/width ratio = 3.6:1, with a partial mucilaginous sheath which becomes everted at maturity to form an irregular to funnel-shaped, apical appendage.

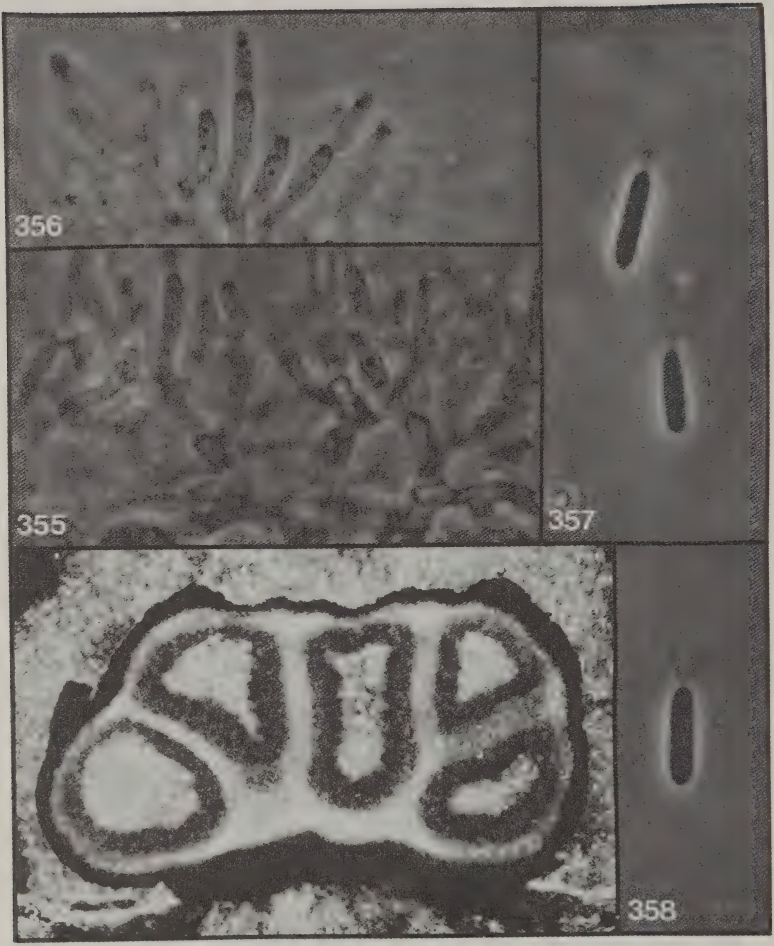
Habitat: see teleomorph.

Known distribution: see teleomorph.

Phacidium sherwoodiae is known only from Oregon, on dead leaves of *Gaultheria shallon* and *Thuja plicata*. The anamorph may be the unnamed species of *Ceuthospora* described above. Another distinct species of *Ceuthospora* was also found on one of the collections examined (Sherwood no. 418). This has larger conidia than those of the suspected anamorph of *P. sherwoodiae*, and appears to be closely related to *C. foliicola* (Lib.) Jaap. Since two dissimilar species of *Ceuthospora* were found associated with *P. sherwoodiae*, it is difficult to be sure which taxon is the actual anamorph, although we have no doubt that the saprobic *P. sherwoodiae* has a *Ceuthospora* anamorph.



Phacidium sherwoodiae. 348. V.S. of an ascoma. x 125. 349. Margin of ascoma. x 310. 350, 351. Ascospores. x 1280. 352. Asci, ascospores and paraphyses. x 770. 353. Ascus apex, arrow indicates amyloid dehiscence mechanism. x 1280.



Ceuthospora anam. of Phacidium sherwoodiae. 354. V.S. of a mature multilocular conidioma. x 125. 355. Subhymenial elements. x 1280. 356. Conidiogenous cells and developing conidia. x 1280. 357, 358. Mature conidia. x 1280.

22. *Phacidium sphaeroideum* Cooke & Ellis Figs. 359-362.
Grevillea 7: 7 (1878).

Foliicolous. Ascomata amphigenous, scattered to gregarious, initially immersed, subepidermal, producing subconical swellings up to 500 µm diam., then splitting the fungal roof stellately into 4-6 irregular teeth; uppermost fungal layer of brown *textura globulosa*; innermost layer of thin-walled, hyaline to subhyaline, smooth-walled periphysoids, with rounded apices and invested in mucilage. Hymenium plane, pale yellow when rehydrated in 2% KOH solution or distilled water alone, up to 75 µm thick, of asci and paraphyses; subhymenium up to 10 µm thick, of closely interwoven, brown hyphae becoming pale yellow toward the hymenium. Asci club-shaped, 8-spored, with an amyloid (I^+) apical dehiscence ring, 62-75 X 8.5-10 ($\bar{x}$ = 69 X 9) µm. Ascospores biseriate, fusiform, ends round, guttulate, pale yellow to subhyaline, smooth-walled, 12-16 X 4-5 ($\bar{x}$ = 14 X 4.5) µm, mean length/width ratio = 3.1:1. Paraphyses branched or simple, septate, with apices slightly swollen and rounded, smooth-walled, up to 75 X 1.5-2.0 µm, invested in mucilage.

Habitat: on leaves of *Ilex glabra*.

Known distribution: U.S.A. (New Jersey).

Specimens examined: In FH, Isotype, J. B. Ellis, Newfield, New Jersey, U.S.A., 1877-IV-30; Ellis North American Fungi no. 456, 1878-I; in S, Isotype.

23. *Phacidium taxicola* Dearness & House Figs. 363-366.
in Dearness, Mycologia 18: 239 (1926).

Foliicolous. Ascomata hypophyllous, sometimes amphigenous, abundant, usually in rows on either side of the midrib, scattered, gregarious, often crowded and confluent, marked by a shining black margin, 300-800 µm diam., subepidermal, raising the epidermis into subconical swellings, then splitting the fungal roof into 3-5 irregular teeth; fungal roof cells arranged in a columnar fashion, of dark brown outer *textura globulosa*, becoming less pigmented toward the interior, innermost layer of subhyaline to hyaline, smooth-walled periphysoids, up to 20 X 3-5 µm, composed of 2-4 cells with gelatinizing outer walls, invested in mucilage. Hymenium plane, light brown to dull grey, up to 65 µm thick; subhymenium hyaline, subhyaline near the basal stroma, of closely packed cells forming a *textura angularis* up to 15 µm thick. Asci club-shaped, 8-spored, flattened slightly toward the amyloid (I^+) apical dehiscence mechanism, 57-60 (-65) X 6-8 ($\bar{x}$ = 58 X 7) µm. Ascospores uniseriate to biseriate, fusiform, ends rounded, usually biguttulate, hyaline, smooth-walled, 7-11 X 3-4 ($\bar{x}$ = 9 X 3.5) µm, mean length/width ratio = 2.5:1. Paraphyses usually simple, septate, hyaline, smooth-walled, up to 60 X 1.5-2.0 µm, invested in mucilage.

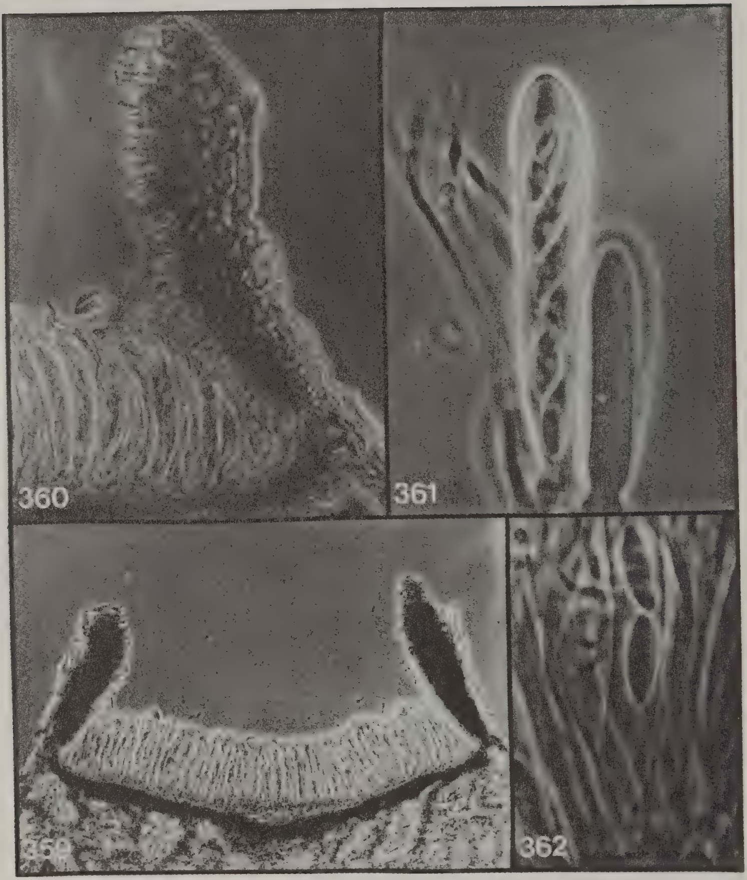
Habitat: on leaves of *Taxus canadensis*.

Known distribution: U.S.A. (New Jersey, New York).

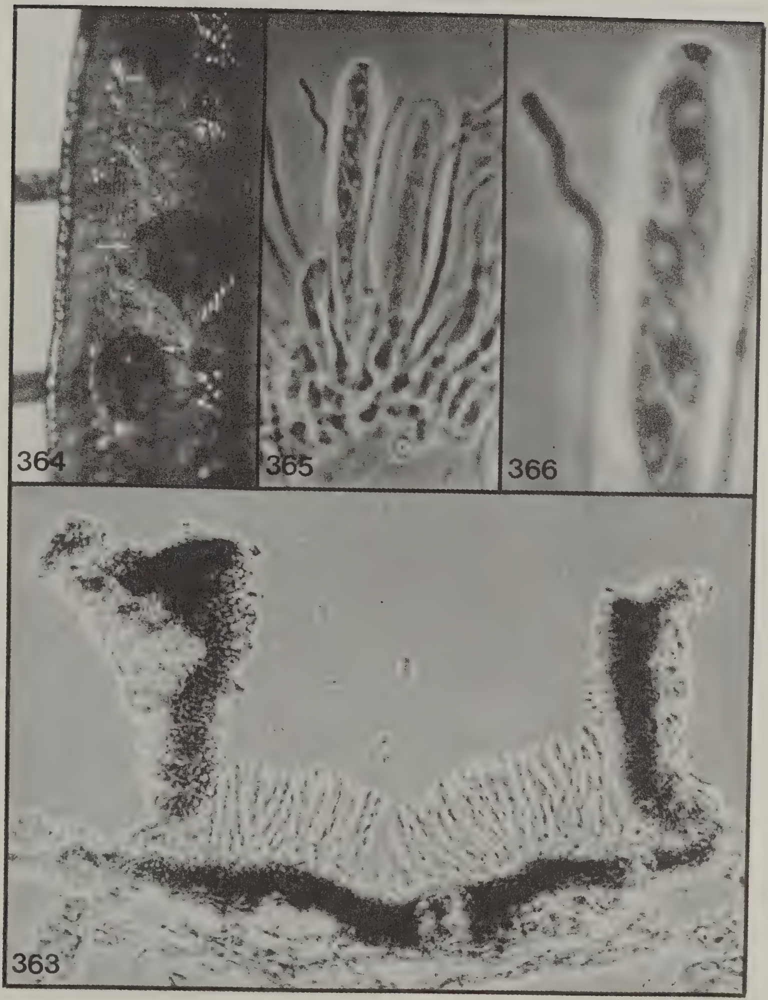
Specimens examined: In DAOM-Dearness 4811, Holotype, H. D. House, Blue Mountain, Hamilton Co., N.Y., U.S.A., 1920-IX; DAOM 4811, H. D. House 1198, Forst Port, Oneida Co., U.S.A., 1925-VII-14; DAOM-Dearness 4811, H. D. House 1124, Newcomb, N.J., U.S.A., 1925-IX-14; DAOM-Dearness 4811, H. D. House 8163, Newcomb, N.J., U.S.A., 1926-VII-10.

Examination of the blighted leaves of *Taxus canadensis* in the holotype collection of *P. taxicola* (*ut P. taxicolum*, Dearness 1926) revealed the presence of a species of *Apostrasseria*. We believe that this represents the anamorph of *P. taxicola*.

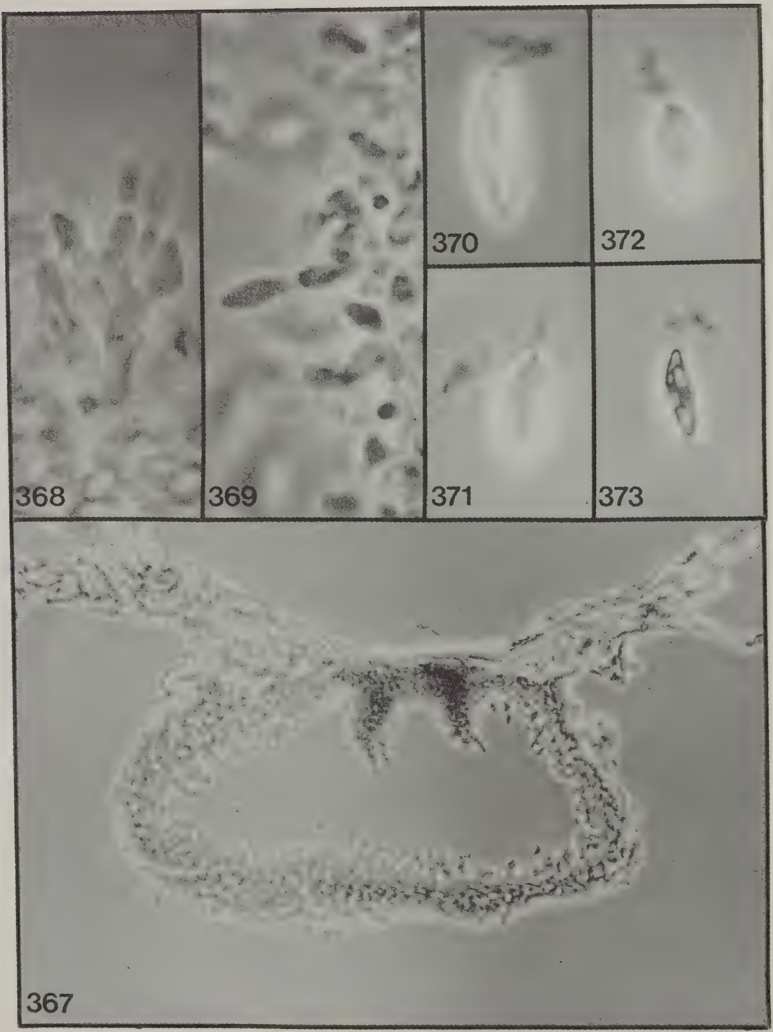
Apostrasseria fusiformis Nag Raj anamorph of *Phacidium taxicola*.
Figs. 367-373.
Nag Raj, Can. J. Botany 61: 17-19 (1983).



Phacidium sphaeroideum. 359. V.S. of an ascoma. x 125. 360. Margin of ascoma showing covering layer and periphysoids. x 310. 361. Ascus: note apical dehiscence mechanism. x 770. 362. Ascospores. x 770.



Phacidium taxicola. 363. V.S. of a mature ascoma. x 320. 364. Habit, arrows indicate ascomata. x 25. 365. Ascus, ascospores and paraphyses. x 770. 366. Detail of ascus apex: note conspicuous apical dehiscence mechanism. x 1280.



Apostrasseria fusiformis anam. of Phacidium taxicola. 367. V.S. of conidioma. x 510. 368. Conidiophore and integrated conidiogenous cells. x 1280. 369. Conidiogenous cell with developing conidium. x 1280. 370-373. Mature conidia with irregular, apical mucilaginous appendage. x 1280.

Foliicolous. Conidiomata pycnidial, hypophyllous, in rows on either side of the midrib, abundant, scattered, gregarious, often confluent, unilocular, sometimes multilocular, subepidermal, globose to subglobose, light brown, becoming darker toward the apex, up to 325 µm diam., ostiolate; wall of light yellow to brown pseudoparenchymatous cells which become red-brown toward the ostiole, and subhyaline to pale yellow near the hymenium. Conidiophores branched, septate, hyaline, smooth-walled, 10-20 X 2.5-4 ($\bar{x}$ = 15 X 3) µm, often reduced to conidiogenous cells (phialides). Phialides simple, subcylindrical, lageniform to ampulliform, 5-11 X 2.5-3.5 ($\bar{x}$ = 8 X 3) µm, arising from the subhyaline to pale-yellow pseudoparenchymatous cells all around the locule and invested in mucilage. Conidia blastic-phialidic, non-septate, ellipsoid to navicular, guttulate, hyaline, smooth-walled, 8-12 (-14.5) X 3-4 ($\bar{x}$ = 10 X 3.5) µm, mean length/width ratio = 2.9:1, invested in a partial mucilaginous sheath which becomes everted at maturity to form an irregular, apical, mucilaginous appendage.

Habitat: see teleomorph.

Known distribution: see teleomorph.

Phacidium taxicola can be confused with *P. dearnessii*, a morphologically similar species found on *Taxus brevifolia*. However, the two species can be easily distinguished on the basis of geographical range, hosts, and anamorphs (see *P. dearnessii* for a discussion of these essential differences).

24. *Phacidium vaccinii* Fries — Figs. 374-380.
Syst. Mycol. 2: 575 (1823).
= *Xyloma erumpens* Fries, Observ. Mycol. p. 575 (1815).

Foliicolous. Ascomata amphigenous, scattered to gregarious, discrete, at first immersed, subepidermal, producing subconical swellings up to 100 µm diam., ultimately rupturing the covering tissues stellately into 3-4 irregular teeth and exposing the underlying hymenium; the fungal roof is composed of dark brown outer *textura globulosa*, paler toward the interior, innermost layer of smooth-walled, hyaline, septate periphysoids up to 10 X 2.4 µm, invested in mucilage. Hymenium plane, of asci and paraphyses, up to 70 µm thick; subhymenium up to 7 µm thick, of hyaline *textura angularis*; basal stroma of brown *textura globulosa*, up to 12 µm thick, and paler toward the subhymenium. Asci club-shaped, 8-spored, 57-69 X 6-7.5 ($\bar{x}$ = 63 x 7) µm, with an amyloid (I^+) dehiscence mechanism. Ascospores biseriate, ellipsoid, straight or slightly curved, hyaline, smooth-walled, 10-13 X 2.5 (-3) ($\bar{x}$ = 11.5 X 3) µm, mean length/width ratio = 4.2:1. Paraphyses abundant, subcylindrical, simple or branched, sparsely septate, hyaline, smooth-walled, up to 70 X 1-1.5 µm, and invested in mucilage.

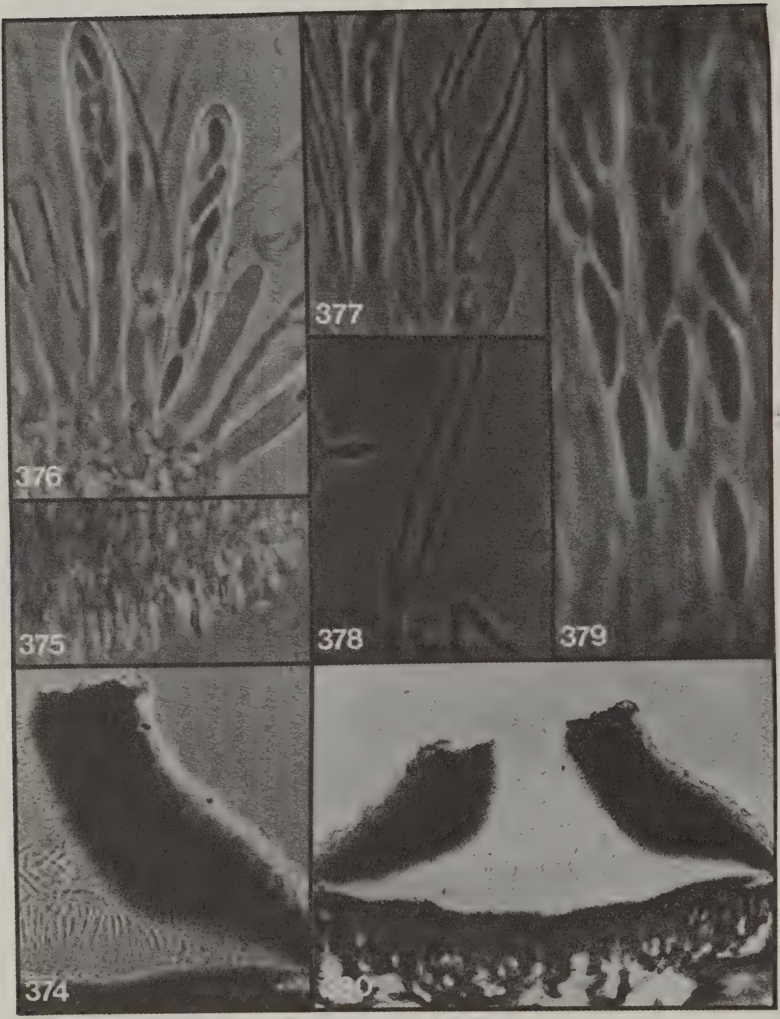
Habitat: on leaves of *Vaccinium vitis-idaea*.

Known distribution: Belgium; England; France; Germany; Sweden.

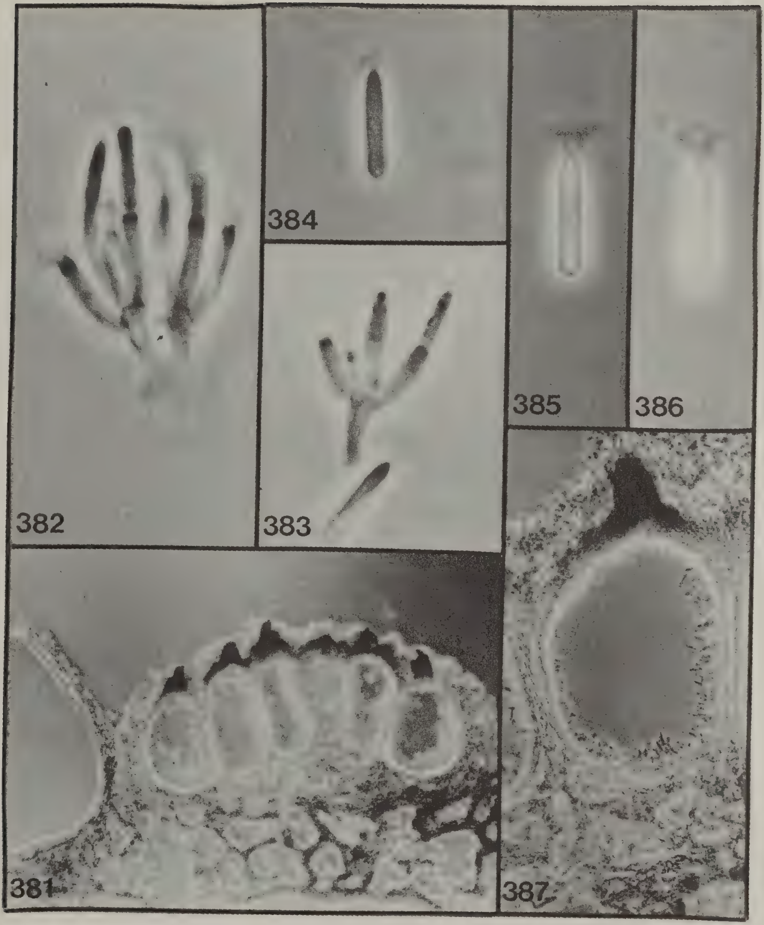
Specimens examined: In BPI, Isotype (?), Scleromyceti Sueciae ed. II, no. 289; in FH, ex Herbier Barbey-Boissier no. 1031 (Fuckel Fungi Rhenani no. 1029), Fuckel, Bavaria, Germany, 1894; Herbier Barbey-Boissier 1032 (Fuckel Fungi Rhenani no. 1029 as *Dothidea latitans* Fr.), Fuckel, Bavaria, Germany, 1894; in UPS, Scleromyceti Sueciae no. 281; in S, Mougeot & Nestler Stirpes Vog. Crypt. ex herb. Rehm; Herbier Barbey-Boissier no. 1031.

Ceuthospora latitans (Fr.) Hoehn. is the presumptive anamorph of *P. vaccinii*.

Ceuthospora latitans (Fr.) Hoehnel — Figs. 381-387.
Mitt. Bot. Inst. Techn. Hoch. Wien 2: 102 (1925).
≡ *Dothidea latitans* Fries, Syst. Mycol. 2: 552 (1823).
≡ *Phyllachora latitans* (Fr.) Sacc., Syll. Fung. 2: 610



Phacidium vaccinii. 374. Margin of mature ascoma. x 125. 375. Periphysoids and portion of fungal covering layer. x 770. 376. Asci and ascospores. x 770. 377. Ascus and branched paraphyses. x 770. 378. Paraphyses arising from subhymenial elements. x 770. 379. Ascospores. x 1280. 380. V.S. of mature ascoma. x 75.



Ceuthospora latitans anam. of *Phacidium vaccinii*. 381. V.S. of compound conidioma. x 75. 382, 383. Conidiophores and conidiogenous cells. x 1280. 384. Conidium with mucilaginous appendages. x 1280. 385, 386. Conidia with funnel-shaped mucilaginous appendages (in distilled water). x 1280. 387. Detail of single pycnidial locule. x 20.

(1883).
≡ Dothiopsis latitans (Fr.) Karst., Hedwigia 23: 20 (1884).
≡ Dothiorella latitans (Fr.) Sacc., Syll. Fung. 3: 241 (1884).
≡ Fusicoccum latitans (Fr.) Karst., Hedwigia 23: 22 (1884).

Foliicolous. Conidiomata pycnidial, epiphyllous, scattered, subepidermal, raising the epidermis into orbicular swellings, ultimately splitting into irregular teeth, scabrous, light brown, up to 1000 µm diam., with up to 30 locules, individual locules variable in shape, 55-70 µm diam., and up to 215 µm tall, bearing individual ostioles, 2-16 µm diam.; composed of light brown textura epidermoidea with cells arranged in a parallel manner, 10-20 µm wide in the vertical walls separating the individual locules, cells in the region of the ostioles often thick-walled, dark brown, and smooth-walled, forming a textura globulosa. Conidiophores simple or branched, septate or reduced to conidiogenous cells (phialides). Phialides arising all around the locules from the innermost, hyaline cells of the wall, bearing minute collarettes, hyaline, smooth-walled, 6.5-10 (-12) X 2 ($\bar{x}$ = 8.5 X 2) µm, invested in a thin mucilaginous matrix. Conidia blastic-phialidic, non-septate, subcylindrical, straight or slightly curved, tapering slightly toward the apex, base obtuse, terminating in a minute denticle, hyaline, smooth-walled, 9-15 X 2 (-2.5) ($\bar{x}$ = 12 X 2) µm, mean length/width ratio = 6:1, invested in a partial mucilaginous sheath which becomes everted at maturity to form an irregular to funnel-shaped, mucilaginous, apical appendage.

Habitat: on leaves of Vaccinium vitis-idaea.

Known distribution: see teleomorph.

Specimens examined: In UPS, Lectotype, E. Fries, Scleromyceti Sueciae no. 281; in BPI, E. Fries, Scleromyceti Sueciae Ed. II, no. 189; ibid in FH; in FH, Herb. Barbey-Boissier 1031 ex Fuckel Fungi Rhenani 1031, Fuckel, Bavaria, Germany, 1894; Herb. Barbey-Boissier 1032 ex Fuckel Fungi Rhenani 1029, Fuckel, Bavaria, Germany, 1894; in S, Herb. Barbey-Boissier no. 1031; in S, Herb. Mougeot & Nestler Stirpes Vogeso Crypt. no. 1178.

25. Phacidium vestergrenii (Rehm) Eriksson Figs. 388-391.
Symb. Bot. Upsal. 19(4): 53 (1970).
≡ Naevia vestergrenii Rehm, Annls. Mycol. 11: 153 (1913).

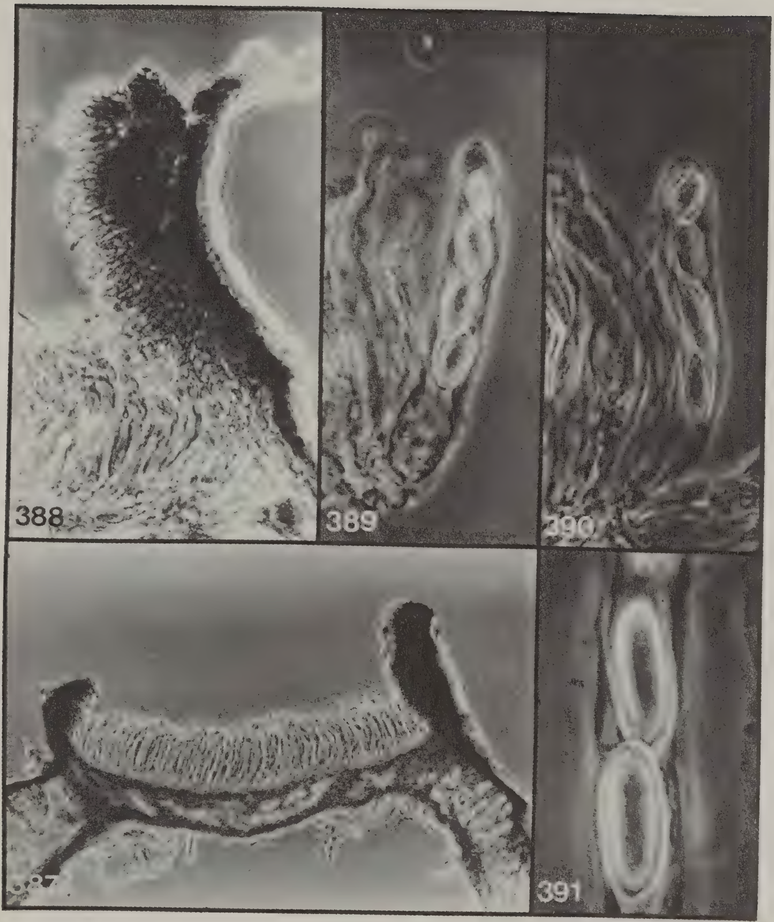
Foliicolous. Ascomata amphigenous, scattered, gregarious, discrete, initially immersed, subcuticular to intraepidermal, forming minute swellings up to 500 µm diam., that ultimately become erumpent, rupturing the overlying host and fungal tissues into 3-5 irregular teeth to expose the hymenium; fungal roof of dark brown, outer textura globulosa up to 80 µm thick above, paler toward the interior, innermost cells hyaline periphysoids. Hymenium plane, up to 62 µm thick, of asci and paraphyses; subhymenium hyaline, of textura angularis, up to 10 µm thick. Asci club-shaped, 55-60 X 7-9.5 ($\bar{x}$ = 57 X 8) µm, usually 4-spored, when 8-spored often with 4 ascospores larger than the rest, with an amyloid (I^+) apical dehiscence ring. Ascospores uniseriate, ellipsoid, hyaline, smooth-walled, 12.5-16 X 4.5-5.5 ($\bar{x}$ = 14.5 X 5) µm, mean length/width ratio = 3:1. Paraphyses usually simple, subcylindrical, septate, hyaline, smooth-walled, up to 62 X 1-1.5 µm, invested in mucilage.

Habitat: on dead leaves of Ledum palustre.

Known distribution: Finland; Sweden; U.S.S.R.

Specimens examined: In UPS, Lectotype, T. Vestergren, Micromycetes rariores selecti no. 1641, Lapponia, Lulensis, Sweden, 1904-VII; J. A. Nannfeldt, Utsjoki, Kevo, Lapponia, Inarensis, Sweden, 1965-VII-15.

Eriksson (1970) stated that the asci of P. vestergrenii were 8-spored. We could not confirm this observation. We usually found 4-spored asci (Figs. 389, 390), although some asci with 4 (apparently mature) and 2-4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Phacidium vestergrenii. 388. V.S. of an ascoma. x 120. 388a. Margin of ascoma. x 310. 389, 390. 4-spored asci. x 770. 391. Two ascospores inside an ascus. x 1280.

(degenerate?) ascospores were observed. Eriksson found that *P. vestergrenii* is "...very similar..." to *P. vaccinii*. It is difficult to interpret what "very similar" meant. We assume that Eriksson was referring to the saprobic habit of *P. vestergrenii*, because it can be readily distinguished from the morphologically distinct *P. vaccinii*.

P. vestergrenii is most similar to *P. grande* (q.v.). However, the two species can be distinguished microscopically.

26. *Phacidium vincae* Fuckel Figs. 392-396.
Jahrb. Nass. Ver. Nat., p. 261 (1869).
= *P. cytisi* Fuckel, Jahrb. Nass. Ver. Nat., p. 328 (1871).
≡ *Pseudophacidium cytisi* (Fuckel) Hoehn., Annls. Mycol. 15: 326 (1917a).
(?) ≡ *Phacidioma cytisi* (Fuckel) Hoehn., Mitt. Bot. Inst. Techn. Hochsch. Wien 2: 102 (1925).

Foliicolous. Ascomata hypophyllous, sometimes amphigenous, gregarious, often crowded but separate, black, circular, 300-1000 µm diam., subepidermal, raising the epidermis into swellings, then splitting the overlying tissue into irregular teeth; fungal roof of dark brown, outer *textura globulosa*, paler toward the interior, innermost layer of subhyaline to hyaline, smooth-walled periphysoids, up to 20 X 3-5 µm, of 2-4 cells, with gelatinizing outer walls, and invested in mucilage. Hymenium plane, grey, up to 65 µm thick; subhymenium hyaline to subhyaline, becoming light brown toward the basal stroma, of *textura angularis* up to 10 µm thick; basal stroma of brown *textura globulosa* up to 30 µm thick. Asci club-shaped, 8-spored, flattened in the region of the amyloid (I$^+$) apical dehiscence ring, 54-69 X 6-8 ($\bar{x}$ = 59 X 7) µm. Ascospores biseriate, subcylindrical to fusoid, straight or slightly curved, ends rounded, non-septate, hyaline, smooth-walled, sometimes guttulate, 10-15 X 2-3 ($\bar{x}$ = 12.5 X 2.5) µm, mean length/width ratio = 5:1. Paraphyses simple or branched, septate, apices swollen slightly and rounded, hyaline, smooth-walled, 50-70 X 1.5-2 µm, invested in mucilage.

Habitat: on stems of *Genista sagittalis* and leaves of *Vinca minor*.

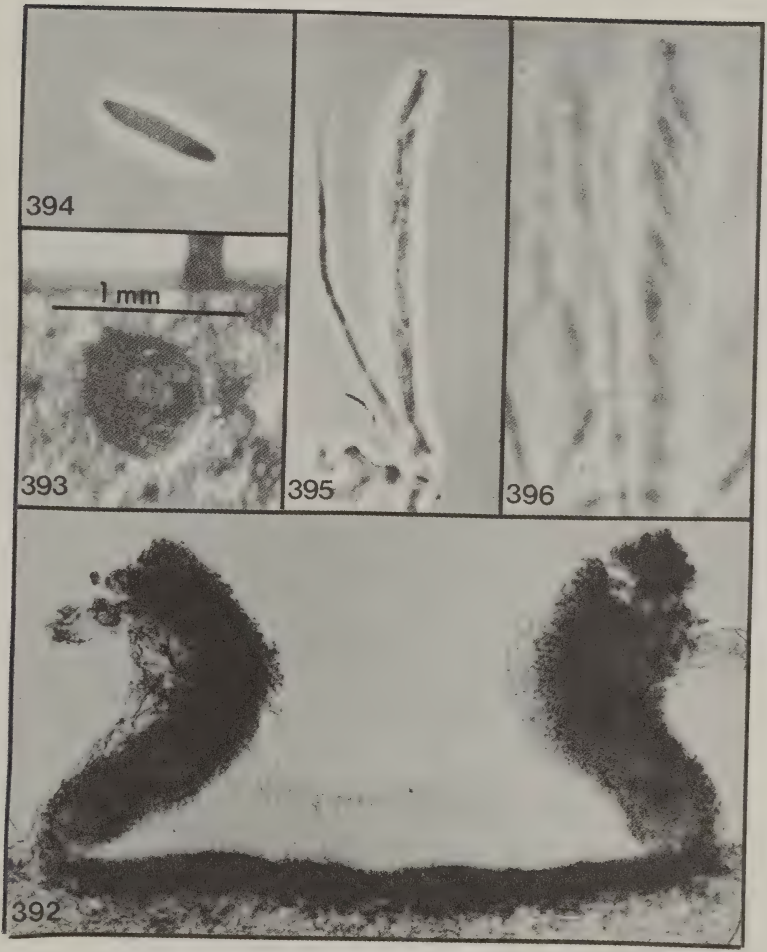
Known distribution: Austria; Poland.

Specimens examined: In DAOM-119833, ex Herb. Barbey-Boissier no. 1030 (*sub Phacidium vincae* Fuckel, fungus spermogonifera), Fuckel, 1894; in FH, Fuckel Fungi Rhenani 1099; *ibid* in S; in S, ex herb. Rehm, Ade, Weismain, 1909; in S, ex herb. Petrak, Fungi polonici exsiccati no. 108, Petrak, 1916-XII-24; in S, ex herb. Rehm, Ade, 1909-V-09; as *P. cytisi*, Lectotype, in FH, ex Herbier Barbey-Boissier 1036 ex Fuckel Fungi Rhenani 2367, Fuckel, Austria, 1894 *ibid* in S.

Ceuthospora foliicola (Libert) Jaap is accepted as the anamorph of *Phacidium vincae*.

Ceuthospora foliicola (Lib.) Jaap Figs. 397-401.
Fungi sel. exs. no. 591 (1913).
≡ *Cytospora foliicola* Libert, Lib. exs. no. 64, in Desmazieres, Ann. Sci. Nat. 17: 117 (1842).
=? *Ceuthospora magellanica* Spegazzini
= *C. feurichii* Bubak, Annls. Mycol. 4: 115 (1906).

Foliicolous. Conidiomata pycnidial, amphigenous, abundant, scattered, separate, erumpent, light brown, often having a black border, initially subepidermal, then extending deeply into the host mesophyll, raising the epidermis into subconical swellings, unilocular, often confluent, glabrous, light brown to light yellow-brown; individual locules globose to depressed globose, 145-215 µm diam., and up to 180 µm tall, bearing individual ostioles which become erumpent, sharing a mutual area of dehiscence, marked by pale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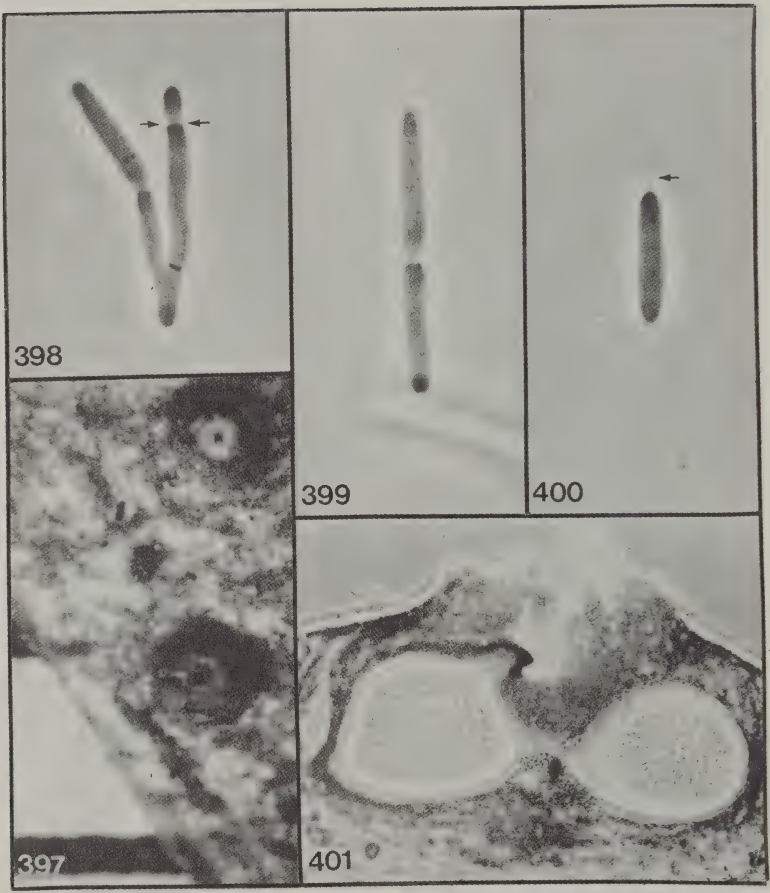
Phacidium vincae. 392. V.S. ascoma. x 130. 393. Habit of teleomorph. 394. Ascospore. x 1280. 395. Ascus septate paraphysis. x 770. 396. Ascus with apical amyloid dehiscence mechanism. x 1280.



Ceuthospora foliicola anam. of *Phacidium vincae*. 397. Habit of conidiomata. x 30. 398. Branched conidiophore, arrows indicate flaring collarette. x 1280. 399. Conidium and conidiogenous cell. x 1280. 400. Conidium, arrow indicates funnel-shaped mucilaginous appendage. x 1280. 401. V.S. of conidioma. x 130.

yellow to subhyaline furfuraceous cells; wall of light brown outer *textura globulosa* up to 15 µm thick, becoming hyaline *textura angularis* toward the hymenium. Conidiophores branched, septate, 15-30 X 2 ($\bar{x}$ = 22.5 X 2) µm, sometimes reduced to simple conidiogenous cells (phialides), all around the locules, arising from the innermost cells of the locules, often proliferating percurrently, hyaline, smooth-walled, 7-18 X 2 ($\bar{x}$ = 12.5 X 2) µm, bearing minute flaring collarettes. Conidia blastic-phialidic, non-septate, subcylindrical, straight or sometimes slightly curved, base rounded, often terminating with a minute dehiscence scar, tapering toward the apex, hyaline, smooth-walled, 10.5-13 X 2.5 ($\bar{x}$ = 12.0 X 2.5) µm, mean length/width ratio = 4.8 :1, invested in a partial mucilaginous sheath which becomes everted at maturity to form an irregular to funnel-shaped, mucilaginous, apical appendage.

Habitat: on fallen, dead leaves of *Berberis vulgaris*, *Cerasus lusitanica*, *Hedera* sp., *Populus* sp., *Quercus* sp., *Vinca minor* and stems of *Genista sagittalis*. Hoehnel (1925) and Groves (1935) cite other possible hosts.

Known distribution: Argentina; Canada (British Columbia); Europe.

Specimens examined: In FH, Lectotype, Libert Exs. no. 64; in DAOM 119833 (see teleomorph); in S, Flora von Eisleben, J. Kunze, 1887; O. Jaap, Triglitz i.d. Prignitz, 1909-VI-03; Fuckel Fungi Rhenani 1099, Moppen, Austria, 1894; Herb. Sydow, Zopf, Eisleben, 1873; Rehm Ascomycetes 2008, Ade, Wiesman (no date); Rabenhorst Fungi europaei no. 1642, J. Kunze, Eisleben, 1872-XII; herb. Rehm, Ade, 1909-V-09; in NY, Desmaszières Plantes Cryptogames de France no. 1626 *ibid* no. 74a & b; *ibid* no. 75a & b; *ibid* no. 571; in LPS, 11559, C. Spegazzini, Tierra de Fuego, 1882-V.

Fuckel (1869/1870) introduced *P. vincae* for a saprobic fungus on dead leaves of *Vinca minor*. He also provided an account of the anamorph, "*Cytispora foliicola*".

The anamorph, *Ceuthospora foliicola*, is apparently found very commonly on leaf litter. Saccardo (1884) recorded *Cytospora foliicola* (≡ *Ceuthospora foliicola*), on *Acer* sp., *Crataegus* sp., *Euonymus* sp., *Hedera* sp., *Quercus* sp. and *Smilax* sp. from Algeria, France, Germany and Italy. Grove (1935) found the fungus in England and considered it a saprobic, plurivorous species. One of us (F.D.) has observed the fungus on *Vinca minor* from British Columbia, Canada. Fuckel (1871) described *Phacidium cytisi* Fuckel on *Cytisus sagittalis*, and found that the presumed anamorph could perhaps be referred to the *Ceuthospora foliicola* anamorph of *P. vincae*. Examination of the pertinent type materials leads us to conclude that *P. vincae* and *P. cytisi* represent the same species, and the anamorph is *Ceuthospora foliicola*.

Hoehnel (1917a) disposed *Phacidium cytisi* in *Pseudophacidium*, but later (Hoehnel 1925) referred it to *Phacidioma cytisi* (Fuckel) Hoehn., and introduced *Ceuthospora cytisi* Hoehn., for its anamorph. We have not been able to find any reference to *Phacidioma* Hoehn., other than that by Hoehnel (1925). Hoehnel apparently intended the name *Phacidioma* to be introduced in that publication. It was not validly published because Hoehnel did not provide a diagnosis or description for it. Likewise, *C. cytisi* is invalid and has no nomenclatural standing.

PRESUMPTIVE ANAMORPHS OF *PHACIDIUM*.

We have already pointed out that the anamorphs of species of *Phacidium* are either *Apostrasseria* spp. or *Ceuthospora* spp. Undoubtedly, the anamorphs can occur well separated in both time and space from the teleomorphs, although in this group they are often found in very close association.

Article 59 of the International Code of Botanical Nomenclature decrees that the name applicable to "...all states which are states of any one species..." is the earliest legitimate name typified by the teleomorph. Similarly, an anamorph name refers only "...to the state represented by its type." The article also states that specific or subspecific anamorph names may be proposed at the time of publication of the teleomorph name, or even later. The code does not require that anamorph names be provided or used. However, the provision of anamorph names has considerable practical value (Luttrell 1978, 1979).

It has become evident that the anamorphs of *Phacidium* express two 'natural' groupings that can be useful in predicting the identity and lifestyle of the teleomorph. Thus it seems worthwhile to describe the taxa which follow, since they are presumptive anamorphs of *Phacidium* species.

1. *Apostrasseria* taxonomic species I. Figs. 402-410.

Foliicolous. Conidiomata pycnidial, scattered, immersed, subepidermal, raising the host tissue into straw-coloured swellings, globose to subglobose, brown above, pale brown below, unilocular, ostiolate, up to 350 µm diam., with a well developed mass of dark brown *textura globulosa* in the apical area of the ostiole; neck up to 200 µm long, of brown *textura globulosa*, wall pseudoparenchymatous, of brown *textura prismatica*, up to 20-25 µm thick, thickest at the base of the neck. Conidiophores sparsely branched, or simple, septate, 7-10 X 3-4 ($\bar{x}$ = 8 X 3.5) µm, invested in mucilage. Conidiogenous cells annellidic, ampulliform to lageniform, hyaline, smooth-walled, 4-6 X 2.5-3 ($\bar{x}$ = 5.0 X 2.5) µm, with 1-3 percurrent proliferations. Conidia blastic-annellidic, non-septate, subreniform, base truncate, 6-9 X 2.5-3.5 (-4) ($\bar{x}$ = 7.5 X 3) µm, mean length/width ratio = 2.5:1, with an irregular, apical, mucilaginous appendage.

Habitat: on leaves of *Pyrola rotundifolia*.

Known distribution: Canada (Nova Scotia).

Specimen examined: In WAT ex WAT: NA 5443, J. K. Morton & J. M. Venn, Digby, Nova Scotia, Canada, 1972-VII-13.

2. *Ceuthospora pyrolae* (Karst.) Hoehn. Figs. 411-416.
Mitt. Bot. Inst. Techn. Hochsch. Wien 2: 102.
≡ *Phacidium pyrolae* Karsten, Grevillea 7: 64 (1878). (nom. illeg. Art. 59, ICBN 1978).
≡ *Dothiopsis latitans* (Fr.) Karst. var. *pyrolae* Karst., Hedwigia 2: 4 (1884).
≡ *Fusicoccum pyrolae* (Karst.) Karst., Acta. Soc. Fauna Fl. Fenn. 6: 10 (1890).

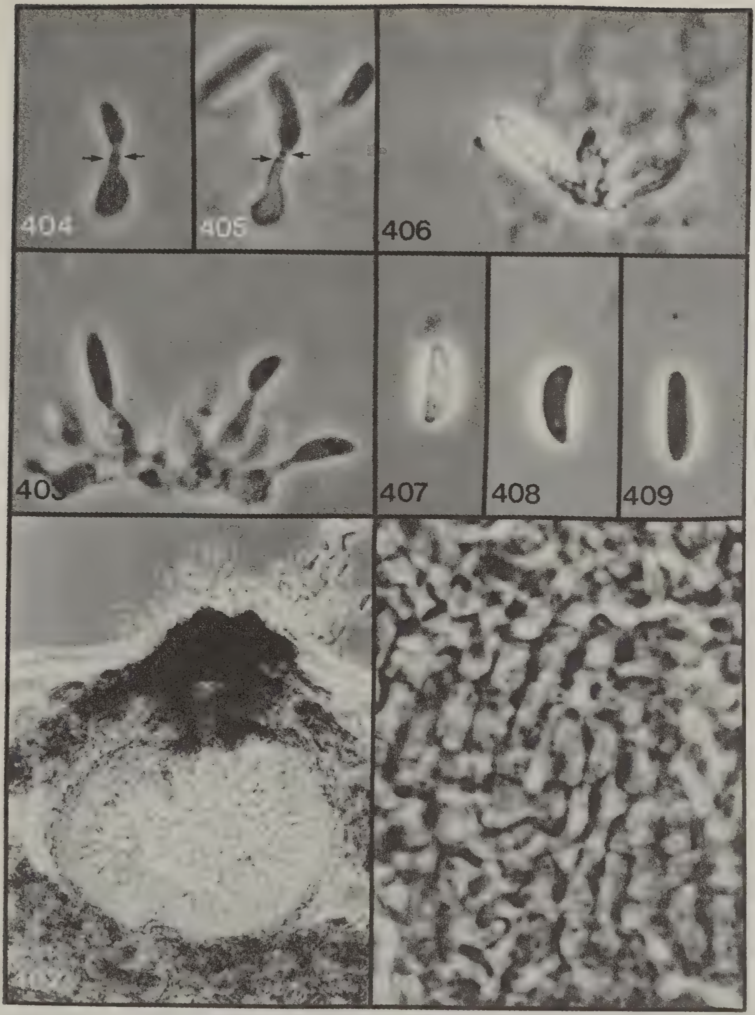
Foliicolous. Conidiomata pycnidial, epiphyllous, scattered to gregarious, subepidermal, raising the epidermis into irregular orbicular swellings up to 1000 µm diam., splitting the overlying host tissue to expose the individual ostioles of separate locules; individual locules subglobose to obpyriform, 150-200 X 100-200 µm; wall pseudoparenchymatous, of brown *textura globulosa* above, pale brown below, hyaline *textura prismatica* toward the hymenium. Conidiophores simple or branched, 10-15 X 2-3 ($\bar{x}$ = 12 X 2.5) µm, often reduced to conidiogenous cells (phialides), invested in mucilage. Conidia blastic-phialidic, non-septate, subcylindrical, straight, slightly tapered above, rounded below, hyaline, smooth-walled, 12-15.5 X 2.5-4 ($\bar{x}$ = 14 X 2.5) µm, mean length/width ratio = 5.6:1, invested in a partial mucilaginous sheath, which everts at maturity to form an irregular to funnel-shaped, mucilaginous, apical appendage.

Habitat: on leaves of *Pyrola rotundifolia*.

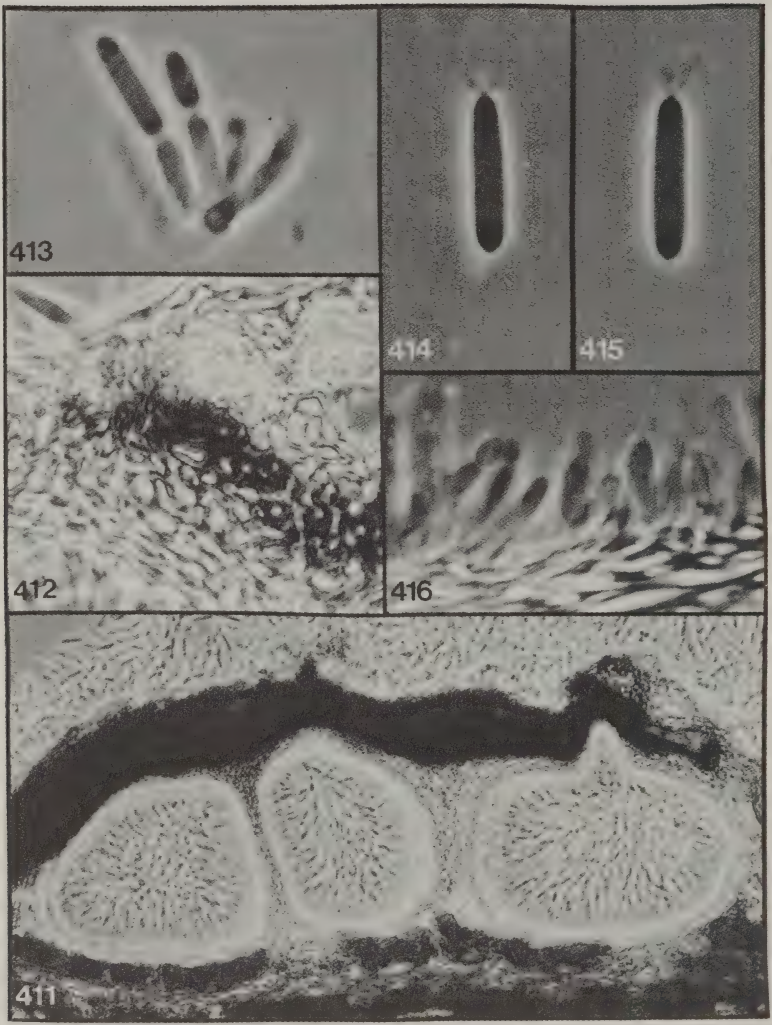
Known distribution: Finland.

Specimen examined: In H, Holotype, ex herb. Karsten 1587, Finland, 1859-IV-24.

Phacidium pyrolae Karsten (Karsten 1878) was introduced for a fungus



Apostrasseria taxonomic species I. 402. V.S. of conidioma. x 310. 403. Conidiophores and conidiogenous cells. x 1280. 404, 405. Conidiogenous cells, arrows indicate percurrent proliferations. x 1280. 406. Conidiogenous cells in mucilage. x 1280. 407. Conidium in distilled water: note apical appendage. x 1280. 408, 409. Conidia in lactic acid. x 1280. 410. Surface view of pycnidial wall. x 1280.



Ceuthospora pyrolae. 411. V.S. compound conidioma. x 205. 412. Detail of apical tissue type. x 1280. 413. Conidiogenous cells, two with developing conidia. x 1280. 414, 415. Conidia. x 1280. 416. Detail of hymenium and subhymenium. x 1280.

found growing on dead leaves of Pyrola rotundifolia. The name Phacidium pyrolae is, by Karsten's own admission, anticipatory; "...fungus ascophorous nondum inventus". It is based on a collection bearing only a Ceuthospora anamorph.

3. Ceuthospora anamorph of (?) Phacidium maderense. Figs. 417-423.
(Phacidium maderense Petrak, Engl. Bot. Jahrb. Beibl. Nr. 142: 139 (1929).)

Caulicolous. Conidiomata stromatic, pycnidial, of 2-4 locules in a sclerotioid, pseudoparenchymatous tissue up to 500 µm thick, of dark brown to black cells forming a textura globulosa, becoming pale brown toward the interior; scattered, oval to irregular in outline, shining black, at first immersed, subepidermal, raising the overlying host tissue into pustules up to 2000 µm long and 1000 µm wide; individual locules ostiolate, with a mutual dehiscence area, subglobulose to globose, 125-200 µm diam., of pale yellow to subhyaline textura prismatica, up to 6.5 µm thick, which becomes hyaline toward the hymenium. Conidiophores arising from the innermost hyaline cells of the locules, branched or simple, septate, hyaline, smooth-walled, 15-30 X 2-2.5 µm, invested in mucilage. Conidiogenous cells phialides, simple or integrated, subcylindrical, hyaline, smooth-walled, 5-10 X 2-2.5 ($\bar{x}$ = 7.5 X 2) µm. Conidia blastic-phialidic, non-septate, subcylindrical, slightly tapered above, rounded below and bearing a minute dehiscence scar, hyaline, smooth-walled, 10.5-14 X 2-2.5 ($\bar{x}$ = 12.5 X 2) µm, mean length/width ratio = 6.3:1, invested in a partial mucilaginous sheath which becomes everted at maturity to form an irregular to funnel-shaped, mucilaginous, apical appendage.

Habitat: on branches of Vaccinium maderensis.

Known distribution: Portugal.

Specimen examined: In S, Holotype, A. Ade, Madeira, Portugal, 1926-VI-03.

The packet in S bearing material of P. maderense on a piece of branch is labelled "Typus" and apparently is the holotype. The collection is scanty and bears only a few conidiomata. We found no teleomorph on this material.

EXCLUDED SPECIES

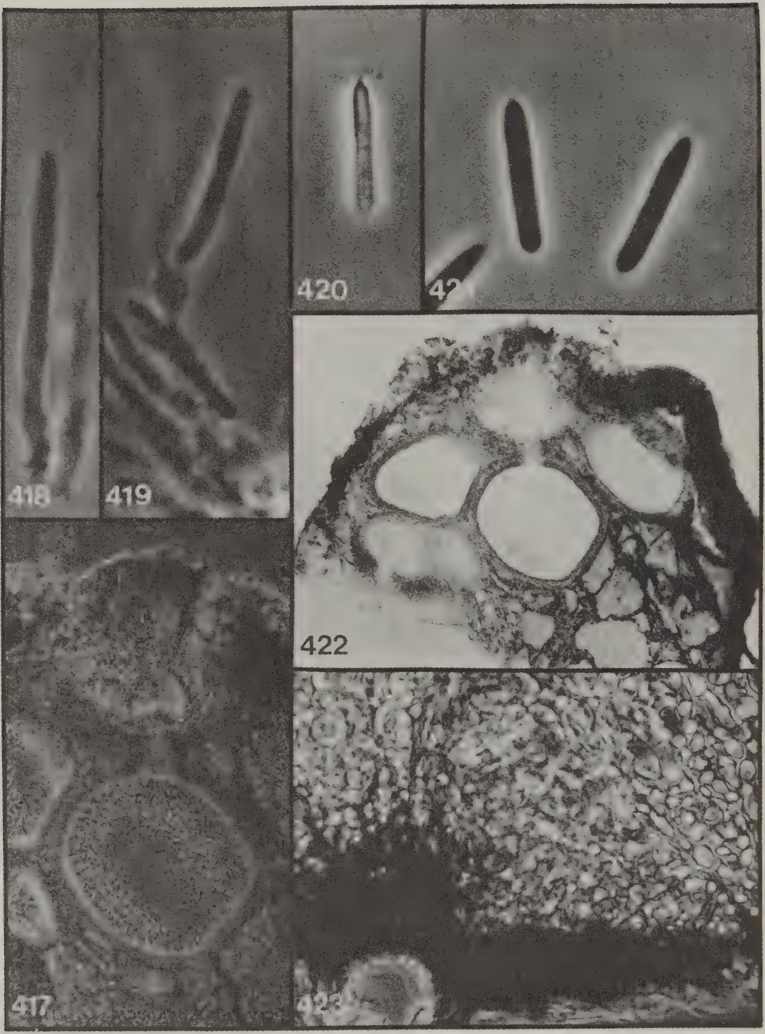
Previous authors have included at least twenty-four genera in the Phacidiaceae sensu lato. We have examined the status of these, and concluded that only two are indeed referable to the Phacidiaceae sensu stricto. The remaining twenty-two genera belong to other families and have already been discussed. During the course of this study over two hundred binomials were found in Phacidium auct. Many of these names were redisposed in other genera, either by previous authors or in this paper. Twenty-six species are accepted in Phacidium, but many other binomials are of uncertain application or have nebulous affinities.

In this section the possible relations of all the species excluded from Phacidium are listed. One hundred and fifty-three names are excluded from Phacidium. We make several taxonomic redispositions. Many species are considered nomina dubia. We were unable to secure type or authentic material of some species, and consequently their identity remains in doubt.

For the purpose of easy retrieval, the species are listed in alphabetical order and are cross-indexed. The binomial we accept is denoted by an asterisk, (e.g., *Nothophacidium abietinellum (Dearness) Reid & Cain).

1. Phacidium abietinellum Dearness, Mycologia 18: 237 (1926).
≡ *Nothophacidium abietinellum (Dearness) Reid & Cain, Mycologia 54: 195 (1962).

Specimen examined: in DAOM, herb. Dearness 5748, Holotype, Orton &



Ceuthospora anam. of Phacidium maderense. 417. One locule of compound conidioma. x 310. 418, 419. Conidiogenous cells with developing conidia. x 1280. 420. Conidium in dilute, aqueous methylene blue: note mucoid appendage. x 1280. 421. Conidia in lactic acid. x 1280. 422. V.S. conidioma. x 75. 423. Detail of basal portion of sclerotioid tissue. x 1280.

Overholts, Newcombe, N.Y., U.S.A., 1924-VIII-22.

Reid & Cain (1962) erected the monotypic genus Nothophacidium, based on N. abietinellum, and suggested that this species was clearly related to the Dermateaceae. They gave a good discussion and illustration.

2. Phacidium acharii (Fr.) Sprengel, Syst. Veg. 4(1): 410 (1827).
≡ Actidium acharii Fr., Syst. Mycol. 2: 596 (1923).

We have not seen type material of this species. The protologue states that the species is ostiolate; this is sufficient to exclude it from Phacidium. The generic name Actidium is now considered to be a synonym of Hysterium.

3. Phacidium affine Sacc. & Paoli, Atti R. Istit. Venet. Sci., Lett. ed Arti 6, ser. VI: 387-428 (1888).
? ≡ Pseudophacidium affine Sacc. & Paoli, cited inSaccardo, Syll. Fung. 8: 777 (1889).

We did not examine any material.

4. Phacidium albidum Phill. & Harkness, Grevillea 12: 83 (1884).
≡ Coccomyces albidus (Phill. & Harkn.) Sacc., Syll. Fung. 8: 746 (1889).
= Naemacyclus phacidioides (Fr.) B. Erikss., Symb. Bot. Upsal. 19(4): 49 (1970).

Eriksson (1970) and Sherwood (1977, 1980) provide descriptions of this species. We have examined type material of P. albidum from BPI and FH. We could find no asci or ascospores.

5. Phacidium alneum (Wormsk. in Fr.) Sacc., Syll. Fung. 8: 715 (1889).
≡ Xyloma alneum Wormsk. in Fr., Syst. Mycol. 2: 573 (1823).
≡ Clithris alnea (Wormsk. in Fr.) Rehm, Kryptogamen Flora p. 106 (1896).

Rehm (1896) believed that this species belonged in Clithris. We have not examined it. The species is here excluded from both Phacidium and the Phacidiaceae on the basis of the published description. No species of Phacidium sensu DiCosmo, Nag Raj & Kendrick has yet been described from Alnus spp.

6. Phacidium andromedae Fr., Syst. Mycol. 2: 574 (1823).
? = Diplodina sp.

Specimens examined: in FH, Scleromycetes Sueciae 132; Karsten Fung. Fenn. 842, Mustiala, Finland, 1967-IX-20; in S, Karsten Fung. Fenn. 842; W. Krieger, Fungi saxonici 1786, W. Tranzschel, Russia, 1903-VII-10(a) and 1903-IX; sub P. vaccinii, leg. Rehm (?), 1874-VIII; sub S. vaccinii, G. Moesz, 1910-VIII-28; Rabenhorst-Pazschke Fungi Europaei et extra-Europaei 4474, W. Krieger, Saxonia, 1903-IX; Rehm Ascomyceten 1534, Krieger, Fichtelberg im Erzeberg, 1903-X.

The fungus described by Fries (1823) is a coelomycete with 1-septate, fusiform, hyaline conidia, and may be a Diplodina. Eriksson (1970) clarified the nomenclatural status of this name vis-a-vis Eupropolella vaccinii (Rehm) Hoehn.

7. Phacidium arctii Libert, Plant. Crypt. Ard. 369 (1837).
≡ Beloniella arctii (Lib.) Rehm, Kryptogamen Flora 3(2): 644

7. *Phacidium arctii* Libert, Plant. Crypt. Ard. 369 (1837).
≡ *Beloniella arctii* (Lib.) Rehm, Kryptogamen Flora 3(2): 644 (1896).
≡ *Fabraea arctii* (Lib.) Sacc., Fung. Lib. p. 10 *teste* Syll. Fung. 8: 736 (1889).
≡ **Spilopodia arctii* (Lib.) Hoehn., Mitt. Sber. Akad. Wiss. Wien 127: 582 (1918).

Specimen examined: in FH, Isotype, Libert Plant. Crypt. Ard. 369. This is not a *Phacidium*.

8. *Phacidium arctostaphylii* Karst., Symb. Myc. p. 256 (1870).
≡ *P. oxycocci* Fr., Syst. Mycol. 2: 575 (1823).
= *P. arctostaphylii* Karst., forma *vitis-idaeae* Sacc., in Bresadola & Saccardo, Malpighia 11: 276 (1897) (*nomen nudum*).
= *P. arctostaphylii* Karst, forma *vaccinii* Sacc., in D. Saccardo, Mycotheca Ital. 1058 (1903) (*nomen nudum*).
= **Eupropolella vaccinii* (Rehm) Hoehn., Annls. Mycol. 15: 311 (1917a).

Eriksson (1970) provided an expanded synonymy, cleared up the nomenclatural confusion around the names used for *E. vaccinii*, provided an illustration of this species, and demonstrated that it is not a *Phacidium*.

9. *Phacidium arctostaphylii* forma *andromedae* Negru, in Negru & Sandor, Izv. Akad. Nauk. Armyan. S.S.R., Biol. Sci. 18: 59 (1965).

The fungus was originally described from Romania. The type material is not in CLUJ. At the suggeston of Dr. O. Ratiu (CLUJ, *in litt.* 1979-VI-11) we directed our inquiry for type material directly to Dr. Negru. We have had no reply. The species is probably another synonym for *Eupropolella vaccinii*.

10. *Phacidium arundinaceum* Cesati, Hedwigia 1: 102 (1856).

The original illustration of this species is undiagnostic, and the material we examined (in S, Rabenhorst Fungi Europaei 728), did not allow adequate characterization.

11. *Phacidium astrantiae* Cesati, in Rabenhorst Herb. Myc. Nr. 258 (1885).
≡ *Pseudopeziza astrantiae* (Ces.) Sacc., Syll. Fung. 8: 724 (1889).
≡ *Fabraea astrantiae* (Ces.) Rehm, Kryptogamen Flora 3(2): 602 (1896).
≡ **Leptotrochila astrantiae* (Ces.) Schueep, Phytopathol. Z. 36: 260 (1959).

Schueep (1959) clearly showed that this species was best referred to *Leptotrochila* of the Pseudopezizoideae.

12. *Phacidium aterrimum* (Fckl.) Sacc., Syll. Fung. 8: 713 (1889).
≡ *Pezicula aterrima* Fuckel, Jahrb. Nass. Ver. Natur. 23/24: 278 (1869/1870).
≡ *Patinella aterrima* (Fuckel) Rehm, Kryptogamen Flora 3(1): 312 (1896).

We have not examined any material, but the published descriptions seem to exclude the species from Phacidium.

13. Phacidium autumnale Fuckel, Jahrb. Nass. Ver. Naturk. 23/24: 262
(1869/1870).

See Phacidium verrucosum.

14. Phacidium bacilligerum Karsten, Not. Fauna Flor. Fenn. 8: 209 (1886).
≡ Patellaria bacilligera (Karst.) Karst. Bidrag Kaennedom Finlands Natur. Folk 19: 237 (1871).
≡ Sphaeropezizella bacilligera (Karst.) Karst., Rev. p. 157 (1885).
≡ Scutularia bacilligera (Karst.) Sacc., Syll. Fung. 8: 809 (1889).
(?) ≡ *Karstenia bacilligera (Karst.) Karsten, fide herbarium packet in H.

Specimen examined: in H, Holotype, P. A. Karsten 2121, Lapponia, Tulomensis, Kola, 1861-VII-25; part of type P. A. Karsten 2120.

The species is not a Phacidium, but is undoubtedly a Karstenia (as noted on the herbarium packets in H). However, we have not been able to trace the date or vehicle of publication of this combination.

15. Phacidium balsameae Davis, Trans. Wisc. Acad. Sci., Arts, Letters 20: 424 (1922).
≡ Stegopezizella balsameae (David) Sydow, in Sydow &Petrak, Annls. Mycol. 22: 392 (1924).
≡ *Sarcotrochila balsameae (Davis) Korf, Mycologia 54: 29 (1962).

Anamorph: Kabatiella balsameae (Davis) Arx.

The nomenclatural status of this species has been documented by Korf (1962). He found that S. balsameae belonged to the Hemiphacidiaceae. Bonar (1962) discussed the life cycle of Stegopezizella balsameae, and found the anamorph to be Gloeosporium balsameae Davis. Arx (1957) transferred the anamorph to Kabatiella balsameae Davis.

16. Phacidium brunneolum Peck, N.Y. State Mus. Rept. 31: 48 (1879).

See P. verrucosum.

17. Phacidium buxi Lasch, in Klotzschii Herb. Viv. Mycol. 1: 1154 (1847).
= *Guignardia miribelii van der Aa, Persoonia 8: 283-289 (1975).

Anamorph: Sarcophoma miribelii (Fr.) Hoehn., teste van der Aa (1975).

We have not seen any material of this taxon.

18. Phacidium calthae Phill., in Stevenson, Myc. Scot. 344 (1879).
≡ Phacidium calthae Phill., apud Phill. & Plowr. Grevillea 8: 103 (1880).
≡ *Pseudopeziza calthae (Phill. in Stev.) Massee, Brit. Fung. Fl. 4: 192 (1895).

P. calthae was originally introduced in Stevenson (1879, ut P. calthae "in litt."). Later, Phillips & Plowright (1880) created a later homonym. The species is best retained in Pseudopeziza. Schueep (1959) provided a detailed account of Pseudopeziza Fuckel.

19. Phacidium calyciforme (Fr.) Fr., Elench. Fung. 2: 131 (1828).
≡ Cenangium calyciforme Fr., Syst. Mycol. 2: 183 (1823).
≡ Tryblidium calyciforme (Fr.) Rehm, Kryptogamen Flora p. 196 (1896).

Specimens examined: in FH and UPS, Scleromyceti Sueciae no. 99.

The species is not a Phacidium.

20. Phacidium capsulare Schweinitz, Trans. Am. Phil. Soc. (New Series) 4: 243 (1834).

On the type material (in FH, Schw. Amer. Bor. 2055) we found an ostiolate fungus in depauperate condition, without asci or conidia. We consider P. capsulare a nomen dubium.

21. Phacidium carbonaceum Fr.:Fr., Syst. Mycol. 2: 574 (1823).
≡ Xyloma carbonacea Fr., Obs. Mycol. 2: 359 (1818).
≡ Discella carbonacea (Fr.:Fr.) Berk. & Br., Ann. & Mag. Nat. Hist. ser. 2, 5: 377 (1850).
≡ Coccomyces carbonaceus (Fr.:Fr), Quelet, Enchirid Fung. 337 (1886).

Sherwood (1980) presented a brief resume of this species. The specimen we examined (No. 210 of the original edition of Scleromyceti Sueciae) contains a coelomycete with pycnidial conidiomata that is referable to Rhabdospora. A note (Boerema, in litt. 1967-IV-21) accompanying the material suggests that the species may be R. longispora Ferraris (in Malpighia, p. 498 (1904)).

Clearly, the type specimen in the original edition of Scleromyceti Sueciae is different from the fungus described by Berkeley & Broome (1850), which is the anamorph of Cryptodiaporthe salicella (Fr.) Petrak (teste Butin, Phytopath. Z. 32: 411-413 (1958)).

22. Phacidium caulinicola Schw., Trans. Am. Phil. Soc. (New Series) 4: 243 (1834).
= ? Leptostroma sp.

Specimen examined: in BPI and FH, Isotypes, Schweinitz 2054, Bethlehem, Pennsylvania, U.S.A.

The type material contained only a coelomycete, described as follows: Caulicolous. Conidiomata pycnidioid, scattered to gregarious, sometimes confluent, subcircular to irregular in outline, up to 250 µm diam., no definite ostiole present, dehiscent by irregular lacerations of the brown upper covering layer of textura epidermoidea; basal stroma of 2-3 layers of brown pseudoparenchymatous cells forming a textura globulosa which is hyaline toward the hymenium. Conidiophores arising from the innermost, hyaline cells of the basal stroma, sparsely branched, septate, hyaline, smooth-walled, up to 22 µm long and 3 µm wide, terminating in hyaline conidiogenous cells which are lageniform, hyaline, smooth-walled, 7-10 X 2-3 ($\bar{x}$ = 8.5 X 2.5) µm, that proliferate sympodially 1-4 times. Conidia holoblastic, subcylindrical, apex rounded, tapered slightly to a truncate base, guttulate, hyaline, smooth-walled, 5-7 X 1-2 ($\bar{x}$ = 6 x 1.5) µm.

This species may be referable to Leptothyrina Hoehn., or Leptostroma Fr.:Fr. It may represent Leptostroma scirpinum Fr.

23. *Phacidium cerastiorum* (Wallr.) Gill., Champ. Franc. p. 169 (1879).
≡ * *Leptotrochila cerastiorum* (Wallr.) Schueep, Phytopathol. Z. 36: 261 (1959).

Schueep (1959) provided a good description of *L. ceratiorum*, which he referred to the Pseudopezizoideae.

24. *Phacidium clematidis* Phill., Grevillea 17: 46 (1888).
≡ *Coccomyces clematidis* (Phill.) Sacc., Syll. Fung. 8: 751 (1889).
≡ **Karstenia clematidis* (Phill.) Sherwood, Occ. Pap. Farlow Herbarium 15: 109 (1980).
Specimen examined: in K, Holotype, Dr. Carlisle, England.

Sherwood (1980) transferred *P. clematidis* to *Karstenia* Fr. in Karst., and provided a redescription.

25. *Phacidium clusiae* Lev., Ann. Sci. Nat. Bot. ser. 4, 20: 291 (1863).
≡ **Coccomyces clusiae* (Lev.) Sacc., Syll. Fung. 8: 747 (1889).
= *Phacidium musae* Lev., Ann. Sci. Nat. Bot. per. 3, 5: 303 (1846), *nom. rej. prop. teste* Sherwood (1980).
≡ *C. musae* (Lev.) Sacc., Syll. Fung. 8: 752 (1889).
= *P. pluridens* Berk. & Curt., J. Linn. Soc. (London) 10: 371 (1868).
≡ *C. pluridens* (Berk. & Curt.) Sacc., Syll. Fung. 8: 747 (1889).
Specimens examined: in FH, Fungi Cubenses Wrightiani nos. 581, 713, 873; Wright no. 533 ex herb. Curtis.

Sherwood (1980) monographed *Coccomyces* DeNot. and illustrated *C. clusiae*. At that time, she discussed the confusion associated with the application of the name *P. musae*.

26. *Phacidium commodum* Rob., in Desmazieres, Ann. Sci. Nat. Bot. ser. 3, 8: 180 (1847).
≡ **Pyrenopeziza commoda* (Rob.) Nannf., Nov. Act. Reg. Soc. Sci. Ups. ser. IV, 8: 144 (1932).

We have not examined any material of this taxon.

27. *Phacidium commutatum* Fr., (*in scheda*?)

Specimen examined: in FH, Fries Scleromyceti Sueciae no. 164.

The material we examined was in poor condition, but we established that it did not belong to either *Phacidium* or the Phacidiaceae.

28. *Phacidium compactum* Fr., Summa Veg. Scand. p. 368 (1849).

Saccardo (1889) suggested that the species was related to *P. alneum* (q.v.). *P. compactum* was originally found on *Abies* sp. in Sweden. We have been unable to locate any material.

29. *Phacidium congener* Ces., in Rabenhorst, Herb. Mycol. 1727 (1889).
= *P. ranunculi* (Fr.) Lib., Plant. Crypt. Ard. Fasc. 1: 69 (1839).
= *P. litigiosum* Rob. & Desm., Ann. Sci. Nat. Bot. ser. 3, 8: 181 (1847).
= **Leptotrochila ranunculi* (Fr.) Schueep, Phytopathol. Z. 36: 251 (1959).

30. Phacidium convexum Dearness, Mycologia 18: 238 (1926).
≡ *Hemiphacidium (?) convexum (Dearness) Korf, Mycologia 54:27 (1962).

Specimen examined: in FH, Paratype, G. W. Hedgcock, Davidson R., N. Carolina, U.S.A., 1925-VIII-06.

Korf (1962) removed P. convexum from Phacidium and the Phacidiaceae, but was unsure as to its generic affinity. We retain the name H. convexum pending a monographic revision of the Hemiphacidiaceae. The species is clearly excluded form the Phacidiaceae.

31. Phacidium coopertum (Desm.) Hoehn., Esterr. Bot. Z. 57: 324 (1907).

We have been unable to locate the type material of this species, and are unable to comment on its status.

32. Phacidium coronatum (Schum.) Fr.:Fr., Syst. Mycol. 2: 577 (1823).
≡ *Coccomyces coronatus (Schum.:Fr.) DeNot., Erbar. Critt. Ital. ser. 1: 236 (1859), teste Sherwood (1980).

We have already discussed the nomenclatural and taxonomic problems surrounding this species. Sherwood (1980) presents a detailed treatment of C. coronatus, which should be consulted.

33. Phacidium corticale Schw., Trans. Am. Phil. Soc. (New Series) 4: 243 (1834).

Specimen examined: in BPI and FH, Isotypes, Schweinitz, no. 2053, Bethlehem, Pennsylvania, U.S.A.

Schweinitz (1834) described the species from dried branches of Rhododendron sp. Examination of the depauperate type material did not permit adequate characterization. We found no asci or conidia. The identity of the species is not apparent from the poor protologue. We consider P. corticale a nomen dubium.

34. Phacidium crastophilum Sacc., Syll. Fung. 8: 721 (1889).

From the original description, the species can be excluded from Phacidium. P. crastophilum is perhaps better retained in the Naevioideae (Hein 1976).

35. Phacidium (?) craterium Fr. (in litt.).
≡ ? Sphaeria craterium DC., Fl. France no. 804 (in litt.).

Specimen examined: in UPS, Mougeot & Nestler 986.

The name P. craterium was not formally published by Fries. The material we examined on Hedera sp. presented an immersed, erumpent ascoma which produced asci with an amyloid, apical, dehiscence mechanism. It may have affinities with Pyrenopeziza or the Naevioideae.

36. Phacidium crustaceum Curtis, in Ellis, North American Fungi 445 (1880), (nomen nudum).
≡ *Coccomyces strobi Reid & Cain, Can. J. Botany 39: 1127 (1961).

Specimens examined: in FH, Ellis North American Fungi 445, W. G. Farlow, Newton, Mass., U.S.A.; Ellis & Everhart Fungi Columbiani 1554, J. B. Ellis, Newfield, New Jersey, U.S.A., 1900-V-15.

Reid & Cain (1961) provide a detailed study and synonymy of *C. strobi*. Sherwood (1980) also published an account of this species.

37. *Phacidium curtisii* (Berk. & Rav.) Luttrell, Bull. Torrey Bot. Club 67: 701 (1940).
≡ *Rhytisma curtisii* Berk. & Rav. North American Fungi no. 780 (1859).
≡ **Macroderma curtisii* (Berk. & Rav.) Hoehn., Ber. Deutsch Bot. Ges. 35: 422 (1917).

A detailed acccount of this species has already been presented. See *Macroderma*.

38. *Phacidium delta* Kunze, Linnaea 5: 551 (1830).
≡ **Coccomyces delta* (Kunze) Sacc., Flor. Myc. Lusit. 13 (1893).
≡ *P. quercinum* Desm., Plant. Crypt. France 1644 (1847), *non P. quercinum* Schw., Trans. Am. Phil. Soc. (New Series) 4: 243 (1834), (*nomen dubium*).
≡ *Coccomycella quercina* (Desm.) Hoehn., Ber. Deutsch Bot. Ges. 35: 419 (1917).
≡ *Coccomyces quercinus* (Desm.) Terrier, Beitr. Kryptogamen Flora Schweiz 9: 39 (1942).

Sherwood (1980) has provided a good account of this species. She was, however, unaware that the name *P. quercinum* Desm. was a later homonym of *P. quercinum* Schw. (Schweinitz 1834). This fact should provide no nomenclatural problems unless the names *P. quercinum* are considered for priority, in which case the Schweinitz epithet has precedence. But this should prove to be only a minor problem, because the type material of *P. quercinum* Schw. in BPI and FH bears a fungus in a depauperate state. No asci or conidia could be found. The application of this name is not apparent from the original description, and we here consider *P. quercinum* Schw. a *nomen dubium*.

39. *Phacidium dentatum* Schm.:Fr., Syst. Mycol. 2: 577 (1823).
≡ *P. dentatum* Schm., in Kunze & Schmidt, Mycol. Hefte 1: 41 (1817).
≡ **Coccomyces dentatus* (Schm.:Fr.) Sacc., Michelia 1: 59 (1882).

Specimens examined: in FH, Isotype, Schmidt & Kunze, Deutschlands Schwaemme 106; Fuckel, Fungi Rhenani 1090 and 2185.

This species has been redescribed in *Coccomyces*, and illustrated by Sherwood (1980).

40. *Phacidium dianthi* Fuckel, Jahrb. Nass. Ver. Naturk. 23/24: 262 (1869/1870).
≡ *Coccomyces dianthi* (Fuckel) Rehm, Rabenhorst, Kryptogamen Flora 3(1): 79 (1896).
= (?) *Lophodermina paeoniae* (Rehm) Tehon, Illinois. Biol. Monogr. 13(4): 104 (1935).

Specimens examined: in S, Mycotheca germanica 3328, P. Vogel, Brandenburg, Tamsel Kreis Landsberg (Warthe), 1936-X-02/1937-IX-22; in FH, Fuckel, Fungi Rhenani 1091, Isotype.

The isotype material examined was in poor condition and precluded adequate characterization. However, Sydow's material in S presented a species referable to *Lophodermium*.

Hoehnel (1917a) considered this species to belong in *Coccomycella* Hoehn. Rehm (1896) referred the species to *Coccomyces*. Most recently Sherwood (1980) suggested that *P. dianthi* might be referable to the Naevioideae.

41. *Phacidium diminuens* Karst., Acta Soc. F. Fl. Fenn. 2(6): 160 (1885).
≡ **Hysteropezizella diminuens* (Karst.) Nannf., Nov. Acta Reg. Soc. Sci. Ups. IV, 8: 114 (1932).

We did not see any material of this taxon.

42. *Phacidium diminuens* (Karst.) Karst. var. *prominens* Sacc., Syll. Fung. 8: 721 (1889).
= **Hysteropezizella diminuens* (Karst.) Nannf., Nov. Acta Reg. Soc. Sci. Ups. IV, 8: 114 (1932).

This variety differs from the type variety in possessing more prominent ascomata. However, the two varieties have ascospores with overlapping ranges. We doubt that two varieties should be distinguished. Neither variety belongs in *Phacidium*.

43. *Phacidium diminuens* (Karst.) Karst. var. *tetrasperma* Rehm, in Jaap, Annls. Mycol. 5: 251 (1907).

We have not examined any material of this variety, but the description seems to exclude it from *Phacidium* and the Phacidiaceae.

44. *Phacidium divergens* Rob. in Desm. Plant. Crypt. France ser. 1: (?) 164 or 1641.

The material examined in FH (Roumeguere Fungi Gallici 836 and Desm. Plant. Crypt. France 164 or 1641 (?)) had iodine-negative, 8-spored asci. We refer the species to the Naevioideae *sensu* Hein (1976).

45. *Phacidium elegans* Berk. & Curt., North American Fungi 777 (1859).

Specimen examined: in FH, Ravenel Fungi Caroliniana Fasc. 5, no. 47.

Hoehnel (1909) provided an extensive synonymy for this species and transferred it to *Mycoglaena* Hoehn. The material examined was of an immature loculoascomycete. The species is excluded from the Phacidiaceae.

46. *Phacidium elegantissimum* Berk. & Curt., North American Fungi 779 (1859).

Specimen examined: in K, Holotype, North American Fungi 779, Alabama.

The species was found on leaves of *Ilex* sp. We found no fungus referable to *Phacidium*. A loculoascomycete perhaps referable to *Elsinoe ilicis* Plak. (Plakidas 1954) was found. We exclude *P. elegantissimum* from *Phacidium*.

47. *Phacidium epilobii* Karsten, Fungi Fenn. exs. 833 (1869).
≡ *Trochila epilobii* (Karst.) Karst., Bidrag Finlands Naturk. Folk 19: 250 (1871).

≡ *Naevia epilobii* (Karst.) Karst., Acta Soc. Fauna Fl. Fenn. 2: 168 (1885).
≡ *Phacidium epilobii* (Karst.) Hoehn., Sber. Akad. Wiss Wien 126: 311 (1917c).
≡ *Laetinaevia epilobii* (Karst.) Nannf., Svensk. Bot. Tidskr. 30: 300 (1936).
≡ **Naeviopsis epilobii* (Karst.) Hein, Willdendowia 9: 71 (1976).

Specimen examined: in FH, Isotype, Karsten Fung. Fenn. 833 (1869).

Hein (1976) provided a detailed account and diagrammatic illustration of *N. epilobii* (Naevioideae, Dermateaceae).

48. *Phacidium eryngii* Fuckel, Jahrb. Nass. Ver. Naturk. 23/24: 262 (1869/1870).

Specimen examined: in FH, Krieger Fungi Saxonici 262, Krieger, Koenigstein, 1913-V-17.

The material examined was in poor condition. Two fungi were present. In vertical section, we noted an ascomycete with iodine-negative asci which was parasitized by a *Septoria* sp. The taxon is excluded from *Phacidium* on the basis of the original description and our observations.

49. *Phacidium exasperans* Schw., Trans. Am. Phil. Soc. (New Series) 4: 242 (1834).

Specimens examined: in BPI and FH, Isotypes, Schweinitz no. 2052.

The structures that Schweinitz called *P. exasperans* can be described as subcuticular to intraepidermal, ultimately erumpent stromata of *textura globulosa*. No other pertinent details could be gleaned from the meagre type material. We consider *P. exasperans* a *nomen dubium*.

The packet containing isotype material from FH states that the fungus may be a species of *Asterina* Lev. We were unable to verify this, but found *Coleophoma lauricola* (Bubak) Nag Raj on the isotype of *P. exasperans*.

50. *Phacidium exiguum* (Mout. & Sacc.) Hoehn., Sber. Akad. Wiss. Wien 126: 322 (1917c).
≡ *Naevia exigua* Mout. & Sacc., in Sacc., Syll. Fung. 8: 658 (1889).
= **Ploettnera hyperici* (Vestergren) Hein, Willdendowia 9: 101 (1976).

Hein (1967) has provided a good redescription and illustration of this species, and clearly showed that the species was best retained in *Ploettnera* Henn.

51. *Phacidium expansum* Davis, Trans. Wisc. Acad. Sci. Arts, Letters 20: 424 (1922).
= *Naevia piniperda* Rehm, Hedwigia 31: 302 (1892).
≡ **Sarcotrochila piniperda* (Rehm) Korf, Mycologia 54: 30 (1962).

Specimen examined: in FH, Isotype, J. J. Davis, Ogema, Wisconsin, U.S.A., 1919-VII-29.

Korf transferred the species (*S. piniperda*) to the Sarcotrochileae, Hemiphacidiaceae.

52. *Phacidium falconeri* Henn., Hedwigia 42: 218 (1903).

Henning's ascomycete collection, including the type material of this species, was destroyed in 1943. Grove (1935) suggested that *Ceuthospora rhododendri* might be an anamorph of *P. falconeri*, but provided no convincing evidence. We consider *P. falconeri* a *nomen dubium*.

53. *Phacidium fibrosum* Fries, Scleromyceti Sueciae no. 162.

Specimen examined: in FH, Scleromyceti Sueciae no. 162.

The scanty material examined precluded adequate characterization. The erumpent, sterile fructifications were not characteristic of *Phacidium*.

54. *Phacidium fimbriatum* Schm.:Fr., Syst. Mycol. 2: 578 (1823).
= *P. fimbriatum* Schm., in Kunze & Schmidt, Mycol. Hefte 1: 39 (1817).
= *Coccomyces fimbriatus* (Schm.:Fr.) Quel., Enchirid. Fung. 338 (1886).

We have been unable to locate any authentic material of this species, and its identity is not evident from published descriptions. Sherwood (1980) suggested that it may be a synonym of *C. tumidus* (Fr.) DeNot.

55. *Phacidium fimbriferum* Fr., Syst. Mycol. 3 (index): 140 (1832).

We have been unable to locate any material of this species. Fries (1832) provided no description for the taxon and cited no exsiccatum. He did, however, imply a synonymy that Saccardo (1889) subsequently adopted. In the absence of type material, we consider *P. fimbriferum* a *nomen dubium*.

56. *Phacidium fraxineum* Schw., Trans. Am. Phil. Soc. (New Series) 4: 243 (1934).
= **Discosia* sp.

Specimens examined: in BPI and FH, Isotypes, Schweinitz no. 1059, Bethlehem, Pennsylvania, U.S.A.

The isotype collections examined contained a coelomycete referable to *Discosia* Lib. Over fifty species have been described in *Discosia*, and no adequate treatment of the genus has yet appeared. We therefore hesitate to burden the literature with a new name for a species that may already have been described.

57. *Phacidium friesii* Ces., in Rabenhorst, Herb. Mycol. 1538 (1847).
= **Leptotrochila ranunculi* (Fr.) Schueep, Phytopathol. Z. 36: 251 (1959).

Specimen examined: in FH, Isotype, Rabenhorst-Klotzschii Herb. Mycol. no. 1538 (1847).

This appears to be another synonym of *L. ranunculi* (Fr.) Schueep (≡ *P. ranunculi* (Fr.) Lib. q.v.).

58. *Phacidium fuscellum* Karst., Acta Soc. Fauna Fl. Fenn. 2(6): 160 (1885).
= **Hysteropezizella fuscella* (Karst.) Nannfeldt, Nov. Acta Reg. Soc. Sci. Ups. IV, 8(2): 115 (1932).

Specimens examined: in H, Karsten no. 2111, Finland, 1869-V-11; Karsten no. 2111, Finland, 1868-VIII-30.

Nannfeldt (1932) discussed the history of the name *P. fuscellum*, and transferred the species to *Hysteropezizella* Hoehn., section *Pyrenodiscus* Nannf.

59. *Phacidium gaultheriae* Dearness, Mycologia 9: 350 (1917), *non*
P. gaultheriae Dearness, Mycologia 16: 145 (1924).
≡ **Coccomyces gaultheriae* (Dearness) DiCosmo, Nag Raj & Kendrick Figs. 424-428.
Can. J. Botany 61: 42 (1983).

Coccomyces gaultheriae belongs to a small group of species (*C. ledi* Rehm, *C. leptideus* (Fr.:Fr) B. Erikss.) parasitic on members of the Ericaceae (Sherwood pers. comm. 1979-XII-11).

Phacidium gaultheriae (Dearness 1917) was published for a fungus on living stems of *Gaultheria shallon*. The ascospores were described as "...19-26 X 6-6.5 µ." Dearness (1924) again published the name *P. gaultheriae* for another fungus found growing on dead stems of *G. shallon*. The ascospores were cited as "...18-29 X 6-8 µ". Clearly, *P. gaultheriae* (Dearness 1924) must be rejected (Art. 64). We could not locate the type material of *P. gaultheriae* (Dearness 1917, J. Macoun no. 978) in DAOM or NY. The description published (Dearness 1924) for *P. gaultheriae* strongly suggests that it is identical with *P. gaultheriae* (Dearness 1917). We found ascospores of *P. gaultheriae* (Dearness 1924) to measure 16-24 X 5-7 (x̄ = 21 X 6) µm. This, coupled with the descriptions, host and ecological niches suggest that the two collections represent the same species. We have no hesitation in proposing *P. gaultheriae* (Dearness 1924) as a taxonomic synonym of *P. gaultheriae* (Dearness 1917).

Sherwood (1974) erected the segregate genus *Myriophacidium*, distinguished from *Coccomyces* by its ovoid spores. The erection of a genus on the basis of a single character reflects the deplorable state of the taxonomy of these organisms. We believe that the size and shape of ascospores of *Coccomyces* spp. show a continuum from the long, club-shaped spores of *C. coronatus*, through the short, club-shaped spores of *C. tumidus* (Fr.) DeNot., to the ellipsoid-fusiform spores of *C. gaultheriae*. The ascospores of *Myriophacidium* spp. (Sherwood 1980) appear as simply one end of this spectrum of variation.

60. *Phacidium geographicum* Kickx. Fl. Crypt. Flandres 1: 459 (1867).
≡ ? *Pseudopeziza geographica* (Kickx) Rehm, Rabenhorst Kryptogamen Flora 3(2): 599 (1896).

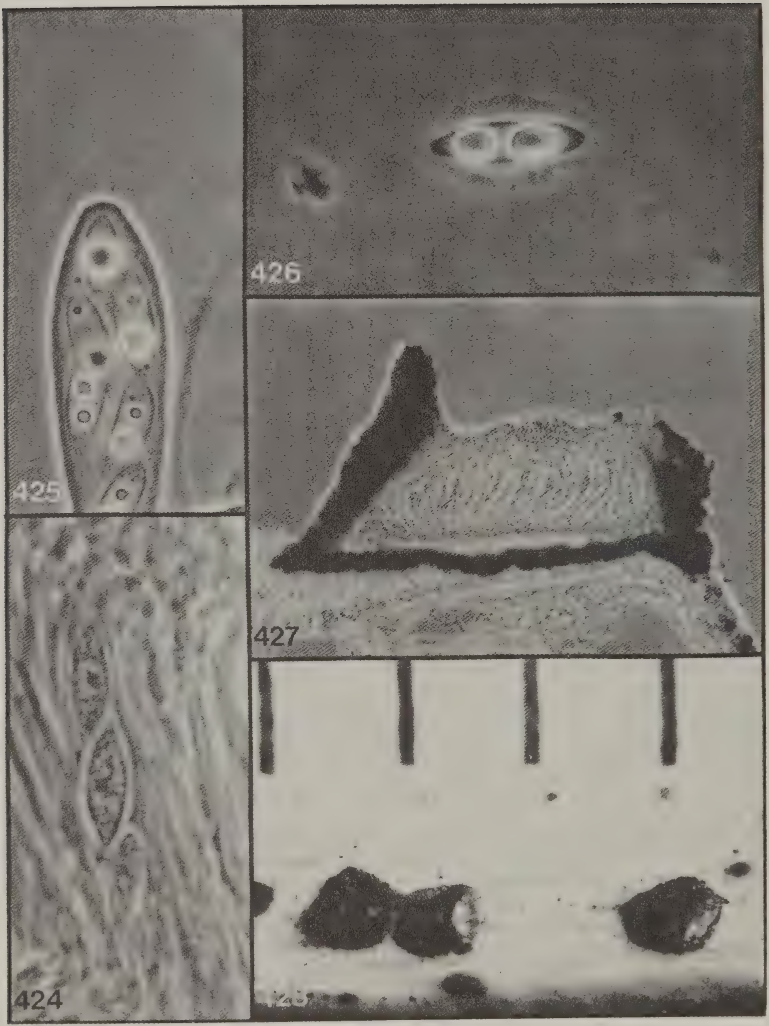
Specimens examined: in FH, de Thuemen Fungi austriaci no. 516, 1872; in S, ex herb. Sydow, coll. de Thuemen, 1872-VIII.

The material examined was sterile, and we could not characterize the species. Nannfeldt (1932) and Schueep (1959) had also been unable to do this.

61. *Phacidium glandicola* Schw., Trans. Am. Phil. Soc. (New Series) 4: 184 (1834).
= **Sphaeropsis* sp.

Specimens examined: in BPI and FH, Isotype, Schweinitz no. 2056, Bethlehem, Pennsylvania, U.S.A.

Examination of the type material has revealed that *P. glandicola* is a coelomycete referable to *Sphaeropsis*.



Coccomyces gaultheriae. 424. Immature ascospores: note that the gelatinous sheath is already present. x 770. 425. Apical region of ascus: note apical dehiscence pore. x 770. 426. Mature ascospore: note gelatinous sheath. x 770. 427. V.S. ascoma. x 120. 429. Habit. x 16.

62. *Phacidium hemisphaericum* Fries, Syst. Mycol. 2: 572 (1823).
≡ *Schizoxylon hemisphaericum* (Fries) DiCosmo, Nag Raj & Kendrick Figs. 429-432.
Can. J. Botany 61: 44 (1983).

Ascomata lignicolous, scattered, separate, black, superficial, pulvinate, orbicular, up to 3000 µm diam., and 1000-1500 µm high, expanding when rehydrated to expose a dense hymenium composed of asci and paraphyses; margin composed of brown to dark brown agglutinated hyphae forming a *textura epidermoidea*. Hymenium 350 µm thick; subhymenium pale brown, 30 µm thick, composed of closely interwoven hyphae with gelatinizing walls; basal stroma 100 µm thick, of *textura epidermoidea*, becoming dark brown toward the base, resting on a hyaline pad of *textura epidermoidea*. Asci 8-spored, clavate, tapering to a slender stipe, thick-walled except for the thin-walled, rounded apex which is non-amyloid (I^-), smooth-walled, 220-300 X 24-32 ($\bar{x}$ = 255 X 28) µm. Ascospores confined to the upper half of the ascus, scolecosporous, flexuous, tapered and rounded above and below, multiseptate, guttulate, hyaline, smooth-walled, 100-130 X 5-6 ($\bar{x}$ = 115 X 5.5) µm, mean length/width ratio = 21:1, disarticulating at the septa to form globose, subglobose to discoid, part-spores, 3-7 X 5-6 ($\bar{x}$ = 5 X 5.5) µm, mean length/width ratio = 1:1. Paraphyses abundant, filiform, branched apically, septate, hyaline, smooth-walled, up to 350 X 2-3 µm, with gelatinizing walls, forming an epithecium, 40-70 µm thick, and turning pale pink (KOH^+) when rehydrated in 2% KOH.

Habitat: on wood of *Betula* sp.

Known distribution: Sweden.

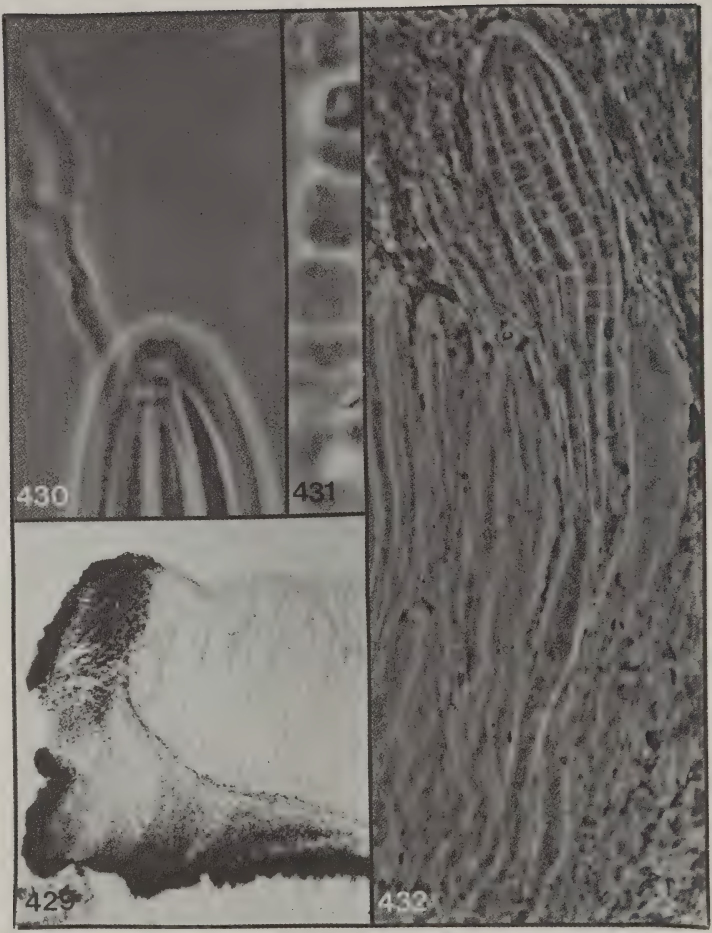
Specimen examined: in UPS, Holotype, in herb. E. Fries, (*sub Phacidium hemisphaericum*), Warmskjold, Kamtschatka.

Phacidium hemisphaericum is known only from the poor type collection in UPS. The dried ascomata are rather tough and carbonaceous, occurring superficially "*in cortice betulino*..." (Fries 1823). When moistened, the ascomata become leathery and expand to expose a dense hymenium, periphysoids are lacking, the hymenium is shallowly cupulate or plane, and the margin slightly involute. This taxon is easily recognized on the basis of the exceedingly wide asci (25-32 µm), and is a species of *Schizoxylon* Pers.

In her study of the Ostropalean fungi, Sherwood (1977a) wrote that asci of *Schizoxylon* may have a thickened apex, pierced by a broad pore, or are without any distinct apical apparatus. *S. hemisphaericum* (≡ *P. hemisphaericum*) deviates from the currently accepted species of *Schizoxylon* in having asci with a relatively thin apex, which presumably ruptures irregularly.

63. *Phacidium humigenum* Cke. & Massee, Grevillea 16: 78 (1888).
= *P. terrestre* (Niessl) Phill., Grevillea 18: 85 (1890).
≡ *Podophacidium terrestre* Niessl, in Rabenhorst Fungi Europaei 1153 (1868).
≡ *Urnula terrestris* (Niessl) Sacc., Syll. Fung. 8: 550 (1889).
= **Podophacidium xanthomelum* (Pers.:Fr.) Shroet., *teste* Nannfeldt, Trans. Brit. Mycol. Soc. 23: 249 (1939).

Specimen examined: in K, Holotype of *P. humigenum*, Dr. Carlyle, Carisle, England; in FH, Isotype of *P. terrestre*, Rabenhorst Fung. Europ. 1153.



Schizoxylon hemisphaericum. 429. V.S. part of ascoma. x 200. 430. Detail of ascus apex and branched paraphysis apex. x 1280. 431. Detail of fragmenting ascospore. x 1600. 432. Ascus and ascospores. x 510.

64. Phacidium hyperici West., Bull. Soc. Bot. Belg. 5(1): (1886).
≡ *Phragmonaevia hyperici (West.) Sacc., Syll. Fung. 8: 676 (1889).

Saccardo (1889) found that Phacidium hyperici produced 3-celled ascospores, and transferred the species to Phragmonaevia Rehm (Helotiales).

65. Phacidium ignobile Karst., Acta Soc. Fauna Fl. Fenn. 2(6): 160 (1885).
≡ *Micropeziza cornea (Berk. & Br.) Nannf., Bot. Not. 129: 335 (1976).

Specimens examined: in H, Lectotype, P. A. Karsten 1535, Finland, 1870-IX-06; Paratype, P. A. Karsten 1534, Finland, 1870-IX-:6; J. Lind, Vaina, Heikinheimo.

Nannfeldt (1967b) provided a concise treatment of this species, an expanded synonymy, and illustrations of some morphological features. The species is clearly excluded from the Phacidiaceae and Phacidium. Nannfeldt's disposition has not subsequently been challenged.

66. (Phacidium infractum Fries, Obs. Mycol. 2: 312 (1818) name change for X. sphaeroides).
≡ Xyloma sphaeroides Pers., Syn. Meth. Fung., p. 106 (1801).
≡ Excipula sphaeroides Pers.:Fr., Syst. Mycol. 2: 191 (1823).
(sanctioned: ICBN, Art. 13.1(f)).
≡ *Drepanopeziza sphaeroides (Pers.:Fr.) Nannf., Svensk. Bot. Tidskr. 25: 20 (1931), (ut D. sphaeroides (Fr.) Nannf.).

Nannfeldt (1931) discussed the nomenclature of the species, and illustrated asci and ascospores. He showed that the name Excipula sphaeroides was a new combination for Xyloma sphaeroides Pers. Fries (1823: 191) points this out. Furthermore, Nannfeldt typified D. sphaeroides with a specimen of Scleromyceti Sueciae no. 138 in UPS. This typification represents a neotypification, and if any of Persoon's original material becomes available, it will necessarily become the lectotype of X. sphaeroides.

We have not attempted to study Persoon's material of X. sphaeroides, because from the published description, it does not seem to represent a species of Phacidium, nor can it be referred to the Phacidiaceae sensu DiCosmo, Nag Raj & Kendrick. Nannfeldt's disposition has not been challenged.

67. Phacidium internum Phillips & Harkness (in scheda ?).
= (?) Tryblidiella macrospora Bonar & Cash, Mycologia 37: 315 (1945).

Specimen examined: in S, Harkness, Yosemite, California, U.S.A.

We have not been able to trace the name P. internum which appears on a herbarium packet in S. Although the material was immature, we found bitunicate asci and 1-septate, brown ascospores. These features exclude the species from Phacidium and the Phacidiaceae. P. internum is probably referable to Tryblidiella.

68. Phacidium jacobaea Fautr. & Roum., Rev. Mycol. 14: 3 (1892).

Specimen examined: in FH, Isotype, Roumeguère Fungi selecti exs. 5927, F. Fautrey, Cote d'Or, 1891-VII.

P. jacobaea was described from fallen stems of Senecio jacobaea. Vertical sections of the caulicolous ascomata showed the species to have affinities with Pyrenopeziza, but we cannot confidently place the species in that genus.

69. Phacidium juniperi (Karst.) Karst., Not. Soc. Fauna Flora 11: 257
 257 (1870), (nomen nudum).
 ≡ P. pini (Alb. & Schw.:Fr.) Fr. forma juniperi Karst.,
 Fungi Fenn. 339 (1866), (nomen nudum), teste Sherwood
 (1980).
 ≡ *Coccomyces juniperi (Karst.):Karst., Bidrag Finlands
 Natur. Folk 19: 254 (1871).

Specimens examined: in H, P. A. Karsten 1542, Kuusamo, Finland, 1861-VI-02; C. G. Tilgerstedt, Finland, 1920-VIII-08 (sub Coccomyces juniperi); P. A. Karsten 1541a 1865-X-24.

Karsten (1866) introduced this species at subspecific rank, but failed to provide a validating description. He subsequently validated the epithet in 1871 when he transferred it to Coccomyces and provided an account of the species.

Sherwood (1980) accepts the species in Coccomyces and provides an expanded synonymy. We accept Sherwood's conclusions.

70. Phacidium kumaonense S. K. Bose & E. Mueller, Indian Phytopathol. 17:
 20 (1964) (ut P. kumaonensis).
 ≡ *Pseudophacidium kumaonense (S. K. Bose & Mueller)
 DiCosmo, Nag Raj & Kendrick Figs. 433-443.
 Can. J. Botany 61: 44 (1983).

P. kumaonense was described from leaves of Quercus leucotrichophora, and we have also studied a collection of this species on Q. glauca, also from India. The species is redescribed herein. It is more appropriately disposed in Pseudophacidium.

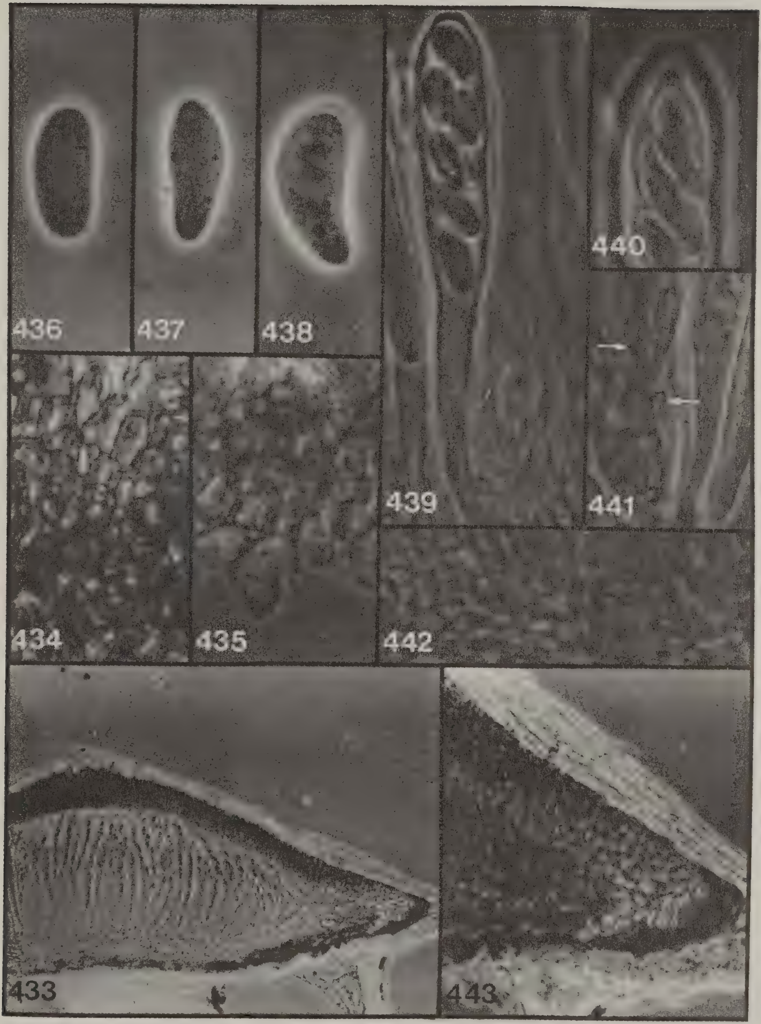
Foliicolous. Ascomata epiphyllous, scattered to gregarious, often confluent, on bleached areas of the host, rectangular or pentagonal to irregular in outline, subcuticular, black, 500-1200 µm diam., of dark brown outer textura globulosa above, becoming hyaline toward the interior; innermost layer of hyaline, subglobose to globose cells, invested in a thin mucilaginous matrix; fungal roof rupturing by 3-5 irregular teeth to expose the hymenium. Hymenium up to 125 µm thick, of asci and paraphyses resting on a pale brown basal stroma of poorly developed textura epidermoidea, 10-15 µm thick. Asci club-shaped, 8-spored, flattened in the region of the non-amyloid (I^-) apical dehiscence pore, 80-125 X 10-12 ($\bar{x}$ = 100 X 11) µm. Ascospores biseriate in the upper portion of the ascus, ellipsoid, fusiform to subreniform, usually thinner below, guttulate, hyaline, smooth-walled, 11-14 X 5-6 ($\bar{x}$ = 12.5 X 5.5) µm, mean length/width ratio = 2.3:1. Paraphyses abundant, branched or simple, septate, tapering toward the apices, not quite as long as the asci, 1.5-2 µm wide, frequently anastomosing with neighbours, and invested in mucilage.

Habitat: on leaves of Quercus glauca and Q. leucotrichophora.

Known distribution: India.

Specimens examined: in ZT, Holoytpe, S. K. Bose, Ranikhet, Kumaon, India, 1962-XII-30; T. C. Sharma, location as above, 1962-X-19.

In the field this species could easily be mistaken for a Coccomyces sp. because of the shape of the ascomata and the bleaching of the substrate. However, close microscopic examination leaves no doubt that it is better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Pseudophacidium kumaonense. 433. V.S. of a mature ascoma. x 125. 434. Detail of fungal roof. x 1280. 435. Inner side of roof. x 1280. 436-438. Ascospores. x 1280. 439. Ascus. x 770. 440. Ascus apex. x 1000. 441. Proliferating croziers (arrows). x 1280. 442. Detail of subhymenium. x 1280. 443. Detail of margin of an ascoma. x 310.

maintained in Pseudophacidium, as a species with reduced ascomata. The generic concept of Pseudophacidium can now include foliicolous taxa. P. kumaonense also shows that the complexity of ascomata of Pseudophacidium spp. follows the general trend we have demonstrated in the Phacidiaceae. Any further systematic research on Pseudophacidium should take this expanded morphological concept into account.

71. Phacidium laciniatum (Alb. & Schw.:Fr.) Fr., Elench. Fung. 2: 132 (1832).
≡ Peziza laciniata Alb. & Schw., Consp. Fung. Nisk. p. 333 (1805).
≡ P. laciniata Alb. & Schw.:Fr., Syst. Mycol. 2: 113 (1823). (sanctioned: ICBN, Art. 13.1(f)).
≡ Heterosphaeria laciniata (Alb. & Schw.:Fr.) Fr., Summa Veg. Scand. pars post p. 365 (1849).
≡ Coccomyces coronatus (Schuem.:Fr.) DeNot. forma laciniatus (Alb. & Schw.:Fr.) Karst., Bidrag Finlands Natur. Folk 19: 257 (1871).
≡ C. laciniatus (Alb. & Schw.:Fr.) Quel., Enchirid. Fung. p. 337 (1886).
≡ *Discocainia laciniata (Alb. & Schw.:Fr.) Torkelsen & Eckblad, Norw. J. Botany 24: 137 (1977).

The proper systematic position of this species has been the subject of debate, as can be deduced from the nomenclator above. It has been widely accepted as a synonym of C. coronatus. However, Torkelsen & Eckblad (1977) suggested that it is better disposed in Discocainia. Sherwood (1980) presents another interpretation, suggesting that P. laciniata may be referable to Tryblidiopsis Karst. In either case, the species should be excluded from the Phacidiaceae.

72. Phacidium laevigatum Fr., Summa Veg. Scand. p. 368 (1849), (nomen nudum).
≡ Hysterium degenerans Fr., in Kunze & Schmidt, Mycol. Hefte 2: 60 (1823).
≡ H. degenerans Fr.:Fr., Syst. Mycol. 2: 585 (1823).
≡ *Sporomega degenerans (Fr.:Fr.) Corda, Icones Fungorum 5: 76 (1842).

Specimens examined: in BPI, Isotype of H. degenerans, Scleromyceti Sueciae 40; in UPS, (sub P. laevigatum), Sweden.

Eriksson (1970) provided an account of S. degenerans, and suggested that Sporomega was related to Pseudophacidium. We cannot fully agree. We believe that Pseudophacidium is most closely allied to the Helotiales (perhaps the Dermataceae). However, S. degenerans has clavate ascospores with gelatinous sheaths. We place Sporomega close to the wood-inhabiting Coccomyces spp. and Lasiostictis of the Rhystimatales.

73. Phacidium latebrosum Quel., "XIII Suppl. p. 9" teste Saccardo, Syll. Fung. 8: 711 (1889).

Saccardo (1889) described the ascospores of P. latebrosum as somewhat curved. The species occurs on petioles of Pyrus torminalis in Europe. We have been unable to obtain material of this species. Its identity remains in doubt. Nevertheless, the shape of the ascospores, and the nature of the host, suggest that this fungus does not belong to the Phacidiaceae.

74. Phacidium laurocerasi Desm., Plant. Crypt. France 1: 118 (1826).

≡ Trochila laurocerasi (Desm.) Fr., Summa Veg. Scand. p. 367 (1849).
≡ Pyrenotrochila laurocerasi (Desm.) Hoehn., Annls. Mycol. 15: 332 (1917a).
≡ *Pyrenopeziza laurocerasi (Desm.) Nannf., Nova Acta Reg. Soc. Sci. Upsal. IV, 8(2): 153 (1932).
= Phacidium laurocerasi Desm. var. major Desm., Plant Crypt. Fr. 992 (1838).

Specimens examined: in FH, Isotype, Desm. Plant. Crypt. France 1: 118 (1826); Isotype of P. laurocerasi var. major, Desm. Plant. Crypt. France 992; Fuckel Fungi Rhenani 112.

Desmazières (1826) introduced P. laurocerasi for a fungus on the underside of fallen leaves of Prunus laurocerasus. The isotype of this species (in FH) bears numerous, erumpent, effete ascomata. Desmazières (1838) described P. laurocerasi var. major and distinguished it from the type variety because of its large ascomata. We consider P. laurocerasi var. major to be referable to P. laurocerasi var. laurocerasi.

Hoehnel (1917a) used P. laurocerasi as the basis of a new genus, Pyrenotrochila Hoehn.

Nannfeldt (1932) disposed P. laurocerasi in Pyrenopeziza.

Greenhalgh & Morgan-Jones (1964) Trochila laurocerasi and diagrammed the ascomata, but did not mentions Nannfeldt's treatment.

It is clear, both from the material we have studied, and from the published data, that P. laurocerasi var. laurocerasi and P. laurocerasi var. major do not belong to Phacidium or the Phacidiaceae.

75. (Phacidium leptideum Fr., Obs. Mycol. 2: 312 (1818)).
≡ P. leptideum Fr.:Fr., Syst. Mycol.2 : 576 (1832). (sanctioned: ICBN, Art. 13.1(f)).
≡ * Coccomyces leptideus (Fr.:Fr.) B. Erikss., Symb. Bot. Upsal. 19(4): 13 (1970).

Eriksson (1970) recognized that P. leptideum was actually a species of Coccomyces, and provided a valuable account of the synonymy, hosts and geographical range in Europe. Sherwood (1980) cited numerous European and North American collections; she also noted that a similar fungus occcurred in Columbia. We have seen no material of this species.

76. Phacidium limitatum Berk. & Curt., J. Linn. Soc. (London) 10: 371 (1868).
≡ *Coccomyces limitatus (Berk. & Curt.) Sacc., Syll. Fung. 8: 747 (1889).

Specimens examined: in FH, Wright 422 ex herb. Curtis; slides made from Wright 422 in K; Isotype, Wright, Fungi Cubensis Wrightiani 714, Combre, Cuba.

Sherwood (1980) discussed the morphology and systematic position of C. limitatum. We accept her conclusions.

77. Phacidium litigiosum Rob., in Desm., Ann. Sci. Nat. Bot. ser. 3, 8: 181 (1847).
= *Leptotrochila ranunculi (Fr.) Schueep, Phytopathol. Z. 39: 251 (1959).

Specimens examined: in FH, isotype, Desm. Plant. Crypt. France 1639; C. Roumeguere, Fungi gallici exs. 2426, 1882-IX.

This species is referable to Leptotrochila ranunculi and has been cited as a synonym of P. congener (q.v.).

78. Phacidium luridum Phill., in Cooke, Grevillea 19: 75 (1890) (ut P. luridum (Berk. & Curt.) Phill.).

Specimen examined: in K, Holotype, Michener, Pennsylvania, U.S.A.

In the Berkeley herbarium in K is located a specimen labelled Patellaria lurida Berk. & Curt., which was never formally published. Phillips in Cooke (1890) introduced the name Phacidium luridum as a new combination for Patellaria lurida. However, the introduction of the name Phacidium luridum must be interpreted as providing the protologue. In effect Phillips introduced a new species in Cooke (1890). Examination of the holotype material has revealed that the species is not a Phacidium and seems to conform well to Pseudophacidium ledi (q.v.).

79. Phacidium luzulinum (Karst.) Libert, (in scheda), Reliquiae Libertianae suppl. 971.
≡ Mollisia luzulina Karst., Bidrag Finlands Natur. Folk 19: 194 (1871).

We could find nothing resembling Phacidium on Rel. Libert. 971 ex FH.

80. Phacidium macrosporum Karst., Acta Soc. Fauna Fl. Fenn. 2(6): 160 (1885).
≡ Trochila macrospora (Karst.) Karst., Bidrag Finlands Natur. Folk 19: 247 (1871).
≡ Phragmonaevia macrospora (Karst.) Rehm, Rabenhorst Kryptogamen Flora 3(1): 162 (1896).
≡ *Hysteropezizella macrospora (Karst.) Nannf., Nova Acta Reg. Soc. Sci. Upsal. IV 8(2): 119 (1932).

Specimen examined: in FH, Isotype, Karsten Fung. Fenn. 843.

This is clearly not a species of Phacidium. Nannfeldt (1932) found the most suitable niche for P. macrosporum to be in Hysteropezizella. His disposition has not been challenged.

81. Phacidium macrum Karst., Not. Sallsk. Fauna Fl. Fenn. 11: 218 (1871).
≡ Coccomyces macer (Karst.) Karst., Bidrag Finlands Natur. Folk 19: 255 (1871).
≡ *Karstenia macer (Karst.) Sherwood, Occ. Pap. Farlow Herbarium 15: 109 (1980).

Sherwood (1980) provided a redescription of Karstenia and transferred P. macrum to it. Sherwood (1977) found that the affinities of Karstenia were obscure.

82. Phacidium marantaceae P. Henn., Annls. Mus. Congo. ser. V, 2: 100 (1907).

Specimens examined: in FH, ? Isotype, H. Vandesyt, Kisantu, Congo, 1906; in S, ? Isotype, (collection data as above).

The immature ascomata we studied did not allow adequate characterization, but the fungus is certainly not a species of Phacidium. Theissen & Sydow (1916) referred it to Delpinoella insignis Sacc. & Trotter.

83. Phacidium medicaginis Libert, Plant Crypt. Ard. 2: 176 (1832).
≡ *Pseudopeziza trifolii (Biv.-Bern.) Fuckel, Jahrb. Nass. Ver. Naturk. 23/24: 290 (1869/1870).

= ? Phacidium medicaginis Lib. forma medicaginis-sativae de Thuemen, Mycotheca gen. 1368.

This is a very common pathogen of Medicago sativa. Schueep (1959) provided an extensive synonymy and detailed discussion of Pseudopeziza trifolii.

84. Phacidium microscopicum Desm., Ann. Sci. Nat. Bot. ser. 3, 16: 318 (1851).

Specimen examined: in FH, Desm. Plant. Crypt. France ser. 3, 794 (1860).

The species was described from leaves of Plantago lanceolata. On the material in FH, we found immersed perithecial ascomata. The species is clearly not a Phacidium.

85. Phacidium minutissimum Auersw., in Rabenhorst, Fungi Europaei exs. 2: 228.
≡ *Naevala minutissima (Auersw.) Hein, Willdenowia 9: 88 (1976).

Hein (1976) clearly showed that the species was better disposed in the Naevioideae (Helotiales).

86. Phacidium minutulum (Sacc. & Malbr.) Hoehn., Sber. Akad. Wiss. Wien 126: 332 (1917c).
≡ P. ulceratum (Phill. & Plowr.) Hoehn, ibid.
= *Ploettnera solidaginis (DeNot.) Hein, Willdenowia 9: 96 (1976).

According to Hein (1976) Ploettnera solidaginis has been described under no fewer than 20 binomials. He showed that the species was common throughout Europe.

87. Phacidium mirabile Cke., Grevillea 19: 75 (1890).

Specimen examined: in K, Holotype, J. J. Therry 6302, 1882-III.

The species has club-shaped, septate ascospores with pointed ends. These are not characteristic of Phacidium and are reminiscent of Godronia spp. The ascal apices are non-amyloid, and the ascoma does not suggest any member of the Phacidiaceae. P. mirabilis is herein excluded from Phacidium and the Phacidiaceae.

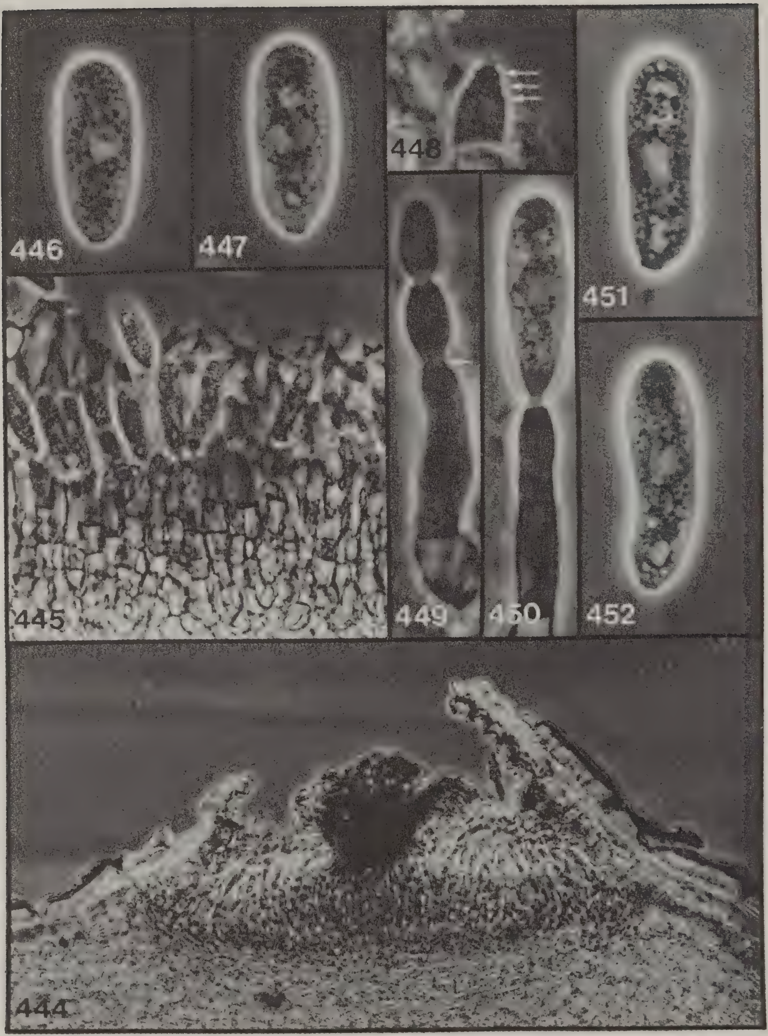
88. Phacidium mollisioides Sacc. & Briard, Rev. Mycol. 7: 210 (1885).
≡ Naevia mollisioides (Sacc. & Briard) Schroet., Schles. Kryptfl. 3(2): 152 (teste Rehm, Rabenhorst Kryptogamen Flora 3(29): 1216 (1896).

The species is not a Phacidium. According to Hein (1976) P. mollisioides is referable to Merostictis Clem.

89. Phacidium musae Lev., Ann. Sci. Nat. Bot. ser. 3, 5: 303 (1846), (nom. rej. prop. teste Sherwood (1980)).

See Phacidium clusiae.

90. "Phacidium negundinis" Tehon & Daniels Mycologia 17: 240 (1925). Figs. 444-452.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"*Phacidium negundinis*". 444. V.S. of conidioma found on holotype. x 205. 445. Detail of hymenium. x 310. 446, 447. Conidia. x 1280. 448-450. Conidiogenous cells, two with developing conidia, arrows indicate percurrent proliferations. x 1280. 451, 452. Conidia. x 1280.

Specimen examined: in ILLS, Holotype, Urbana, Illinois, U.S.A., 1922-VI-03.

The type of P. negundinis bears a coelomycete referable to *Cryptocline abietina Petr. (cf. Morgan-Jones 1973).

Tehon & Daniels (1925) described asci and ascospores (the ascospore measurements they gave in the original publication are erroneous and should read "20 X 7" *teste* holotype packet in ILLS). We could find no asci on the original slide preparation used by Tehon & Daniels. We could find only C. abietina on the holotype.

91. Phacidium nervisequum Ces., in Rabenhorst-Klotzschii Herbarium Viv.
Mycol. 1054.

Specimen examined: in FH, Isotype, Rabenh.-Klotz. Herb. Viv. Mycol. 1054.

The material we examined was poor and did not allow adequate characterization, but the species is perhaps referable to the Naevioideae (Hein 1976).

92. Phacidium nigritulum Rehm, Hedwigia 39: 80 (1900).

Specimen examined: in S, Isotype, Ule no. 179, E. Ule, Estado de sta. Catharina, Brazil, 1884-X; in FH, Isotype (collection data as above).

The subepidermal, epiphyllous ascomata of P. nigritulum are foliicolous, orbicular, black, scattered to gregarious and composed of 3-5 individual locules. The apical fungal tissue ultimately disintegrates and leaves a conspicuous pit on the upper surface of the leaf. This fungus may be referable to Trabutia Sacc. & Roum.

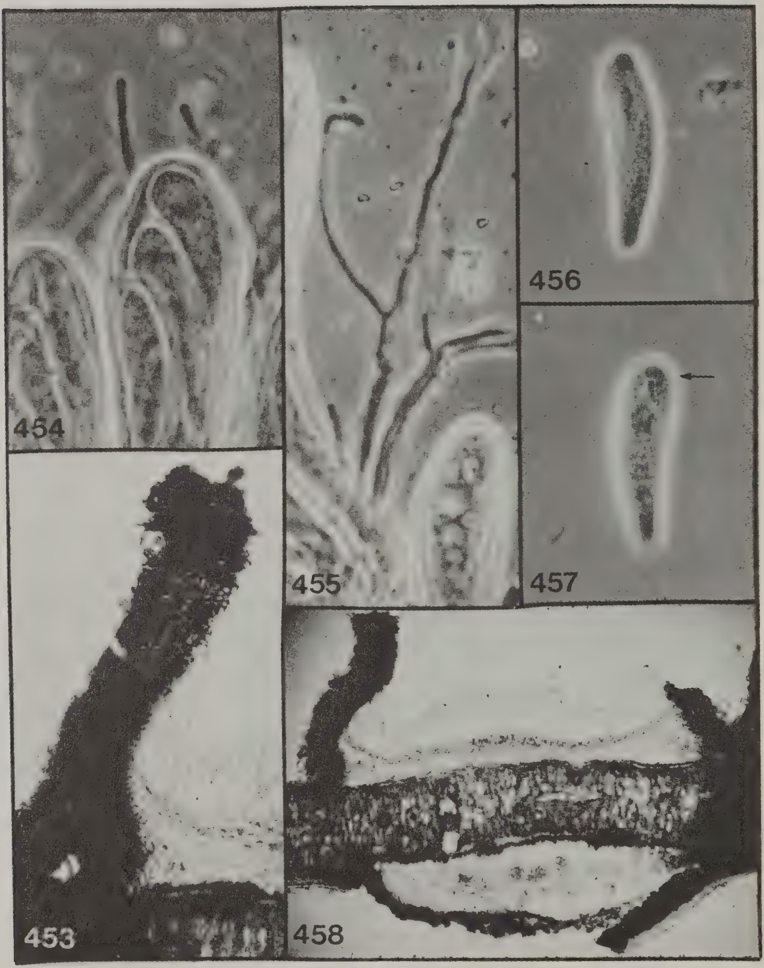
93. Phacidium nigrum Cke. Figs. 453-458.
in Cke. & Harkness, Grevillea 12: 23 (1884).

P. nigrum was published for a fungus on leaves of Xolisma ferruginea (Walt.) Heller (= Lyonia ferruginea Nutt.), collected at Darien, Georgia in 1881 by Ravenel. Cash (1942) provided a good description of the fungus and gave a reasonable taxonomic assessment and description of the fungus. She was well aware that ascomata of P. nigrum were "...more characteristic of Rhytisma than of Phacidium. No swollen cells on the lower surface of the cover, such as are described and illustrated by Nannfeldt (5, pp. 246-247, f. 37-f) and Hoehnel (2, p. 317, f. 15) as an opening mechanism in Phacidium lacerum, have been observed in P. nigrum" (Cash 1942). However, Cash did not make the transfer to Rhytisma.

Our observations, derived from DAOM 18459, differ from those of Cash (1942) only in a few minor details. We found the asci to be clavate, 8-sored, with a thin-walled apex which is non-amyloid (I-), 125-150 X 19-21 ($\bar{x}$ = 137 X 20) µm. The ascospores are biseriate, club-shaped, straight or curved, guttulate, hyaline, smooth-walled, 22-34 X 5-7.5 ($\bar{x}$ = 28 X 6) µm, and have a gelatinous sheath; mean length/width ratio = 4.7:1. Paraphyses abundant, subcylindrical, simple or branched, septate, hyaline, smooth-walled, up to 150 X 1-1.5 µm, and invested in mucilage.

These features are characteristic of the Rhytismataceae. The fungus is probably a species of Rhytisma Fr., and may be R. decolorans Fr. (Fries 1823). However, no formal transfer to Rhytisma can be made without a careful scrutiny of its species.

94. Phacidium (?) nitidum Welw. & Curt., Fung. Ang. p. 279, (*teste*
Saccardo, Syll. Fung. 8: 722 (1889).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"*Phacidium nigrum*". 453. Ascoma, margin and fungal roof. x 130. 454. Ascus apex. x 1280. 456. Branched paraphysis. x 770. 456, 457. Mature ascospores, arrow indicates sheath. x 1280. 458. V.S. of ascoma. x 50.

We have been unable to locate any material of this species. Saccardo (1889) noted "fungus tantum stylosporeus observatus." It is unlikely that this fungus is a Phacidium.

95. Phacidium occulatum Kirsch., Annls. Mycol. 3: 202-203 (1935).

Specimens examined: in B, Lectotype, W. Kirschstein, Hasellake, Grossbehnitz, Germany, 1923-V-10; in H, Isotype, W. Kirschstein (collection data as above).

The lectotype and isotype specimens were both depauperate, and precluded adequate characterization.

96. Phacidium oxycoccos Fr., Syst. Mycol. 2: 575 (1823).
= P. vaccinii Fr. var. oxycoccini Dearn. & House, NY St. Mus. Circ. 24: 29 (1940).
= *Eupropolella vaccinii (Rehm) Hoehn., Annls. Mycol. 15: 311 (1917a).

Specimens examined: in FH, Karsten Fung. Fenn. 841; in DAOM, Holotype of P. vaccinii var. oxycoccini, herb. Dearness 5761, H. D. House, Caroga L., Fulton Co., New York, U.S.A., 1923-VIII-04.

See Phacidium arctostaphylii.

97. Phacidium patella Fr. forma alpestre Fr., Elench. Fung. 2: 133 (1828).

Specimen examined: in FH, Lib. Plant. Crypt. Ard. 269a.

This is not a Phacidium. Rehm (1896) disposed it in Heterosphaeria Grev.

98. Phacidium patella Fr. forma campestre Fr., Elench. Fung. 2: 134 (1828).

Specimen examined: in FH, Lib. Plant. Crypt. Ard. 269b.

This is not a Phacidium. Rehm (1896) referred it to Heterosphaeria Grev.

99. Phacidium patellaria Fr., Summa Veg. Scand. 369 (1849).

We could not locate material of this species. P. patellaria was described from decorticated wood of Pinus sp. in Sweden, and is therefore unlikely to be a species of Phacidium.

100. Phacidium peltiforme Preuss, Linnaea 26: 724 (1853).

See Phacidium trigonum.

101. Phacidium perexiguum Rob., in Desm., Ann. Sci. Not. Bot. ser. 3, 11: 362 (1849).
≡ Microthyriella perexigua (Rob.) Hoehn., Annls. Mycol. 15: 327 (1917a).
≡ *Schizothyrium perexiguum (Rob.) Hoehn., Annls. Mycol. 15: 297 (1917a).

Specimen examined: in FH, Desm. Plant. Crypt. France 793, 1860.

Arx (1959) redescribed and illustrated S. perexiguum. He found that this common member of the Dothiorales had been described at least 18 times.

102. Phacidium philadelphi Niessl., Ver. Zoo. Bot. Ges. Wien 2: 33 (1858).

We have been unable to locate the type material of P. philadelphi.

103. Phacidium phillyreae Passerini, Mem. R. Accad. Lincei Roma p. 457 (1890).
≡ Pyrenotrochila phillyreae (Pass.) Hoehn., Annls. Mycol. 15: 328 (1917a).
= ? *Pyrenopeziza tini (Duby) Nannf., Nova Acta Regiae Soc. Sci. Upsal. IV, 8(2): 162 (1932).
= ? P. laurocerasi (Desm.) Nannf., ibid, p. 153.

Specimen examined: in FH and S, Isotype, O. Jaap, Fungi selecti exs. 609, O. Jaap, Alassio, Liguria, Italy, 1913-I-25; in S, O. Jaap, Varezze, Liguria, Italy, 1913-II-25.

Phacidium phillyreae was transferred to Pyrenotrochila Hoehn., (Hoehnel 1917a). Nannfeldt (1932) considers Pyrenotrochila a synonym of Pyrenopeziza. Both genera are excluded from the Phacidiaceae sensu stricto.

104. Phacidium phomatoides Mont., Syll. generum spec. Crypt. p. 192 (1856).
≡ ? Sphaeria phomatoides Mont., ibid (1856).
≡ ? Physalospora phomatoides (Mont.) Sacc., Syll. Fung. 1: 440 (1882).

No material of Phacidium phomatoides could be found.

105. Phacidium phoenicis Moug., in Fr., Syst. Mycol. 2: 572 (1823).

The species was introduced in Fries (1823: 572). Later, Fries (1828: 135) questioned the generic disposition of the species, and cited Graphiola phoenicis (Mougeot) Poiteau as a synonym. Hoehnel (1917a) believed the fungus to be an anamorph of a member of the Ustilaginales. The status of G. phoenicis has recently been reviewed (Cole 1983, Oberwinkler et al. 1982).

106. Phacidium piceae Fuckel, Jahrb. Nass. Ver. Naturk. 27/28: 51-52 (1873/1874).
≡ *Lophodermium piceae (Fuckel) Hoehn., Sber. Akad. Wiss. Wien 126: 296 (1917c).

Specimens examined: in FH, Fuckel Fungi Rhenani 2561, Germany, 1894; Herbier Barbey-Boissier 1013, ex Fung. Rhenani 2561.

The species has been adequately treated by Darker (1932), who agreed with Hoehnel's disposition.

107. Phacidium pinastri (Fr.) Fr., Elench. Fung. 2: 131 (1828).
≡ Cenangium pinastri (Pers.):Fr., Syst. Mycol. 2: 184 (1823).
≡ Tryblidiopsis pinastri (Pers.:Fr.) Rehm, in Rabenhorst, Kryptogamen Flora 3(1): 194 (1896).

The species is not a Phacidium. Rehm (1896) transferred it to

Tryblidiopsis. The nomenclatural state of the specific epithet is utterly confused: it has been used twice in Cenangium and transferred to the anamorph genus Gelatinosporium Pk.

108. Phacidium pini (Alb. & Schw.) Schm.:Fr., Syst. Mycol. 2: 573 (1823).
≡ *Therrya pini ((Alb. & Schw.) Schm.:Fr.) Hoehn., Sber. Akad. Wiss. Wien 121: 400 (1912).

The species has been discussed by Reid & Cain (1961), who provided a complete synonymy and an illustration.

109. Phacidium pithyum (Fr.):Fr., Elench. Fung. 2: 131 (1828).
≡ Dothidea pithya Fr., Obs. Mycol. 2: 350 (1818).
≡ Cenangium pithyum (Fr.):Fr., Syst. Mycol. 2: 184 (1823).
≡ Tympanis pithya (Fr.:Fr.) Sacc., Syll. Fung. 8: 583 (1889).

Groves (1952) found that this species was not a Tympanis. It is apparent from Groves' description that the organism is not a Phacidium either.

110. Phacidium planum Davis, Trans. Wisc. Acad. Sci., Arts, Letters 20: 424 (1922).
≡ *Hemiphacidium planum (Davis) Korf, Mycologia 54: 26-27 (1962).

Specimen examined: in FH, Isotype, J. J. Davis 269, Mosince, Wisconsin, U.S.A., 1919-VII-07; ibid in S.

Korf (1962) placed P. planum in the Hemiphacidiaceae, and his disposition has not been challenged.

111. Phacidium platani Schw., Trans. Am. Phil. Soc. (New Series) 4: 243 (1834).
= *Discosia sp.

Specimens examined: in BPI and FH, Isotypes, Schweinitz no. 2060, Bethlehem, Pennsylvania, U.S.A.

The type collection bears three fungi, a bitunicate ascomycete, a coelomycete referable to Phoma, and a third taxon which is clearly what Schweinitz had in mind when he coined the name P. platani. This is a member of the coelomycete anamorph-genus Discosia, and may be D. artocreas (Tode) Fries.

112. Phacidium plicatum Fr., Elench. Fung. 2: 132 (1828).
≡ Tympanis plicato-crenata (Schw.) Fr., Syst. Mycol. 2: 175 (1823).

The description in Fries (1823) does not suggest a species of Tympanis (teste Groves 1952) and the description in Fries (1828) is even less suggestive of a species of Phacidium. We have not been able to secure good material of T. plicato-crenata, but have no doubt that the species is best excluded from Phacidium.

113. Phacidium plinthis (Fr.) Fr., Elench. Fung. 2: 134 (1828).
≡ Sphaeria (Actidium) plinthis Fr., Syst. Mycol. 2: 511 (1823).

Specimen examined: in FH, Rabenhorst Klotz. Herb. Viv. Mycol. 1345; in S, Bauer, 1854-IV-17.

We have not seen any authentic material of P. plinthis, but since it occurs on Scirpus lacustris it is unlikely to be a Phacidium.

114. Phacidium pluridens Berk. & Curt., J. Linn. Soc. (London) 10: 371 (1868).

Specimen examined: in FH, ? Isotype, Fungi Cubensis Wrightianum 713.

See Phacidium clusiae.

115. Phacidium populi Lausch, in Rabenhorst Herb. Mycol. Ed. 2: 519 (1857).
= *Pezicula ocellata (Pers.) Seaver, North Am. Cup Fungi (Inoperculates), p. 345 (1951).

Specimen examined: in FH, Isotype, Rabenhorst Herb. Mycol. 519.

Seaver (1951) referred P. populi to Pezicula ocellata (Pers.) Seaver.

116. Phacidium pumilum Rob., Ann. Sci. Nat. Bot. ser. 3, 9: 361 (1849).

Specimen examined: in FH, ex herb. Patouillard sub P. pumilum.

The material examined was of a coelomycete. Hoehnel (1917a) found P. pumilum to be a synonym of Gloeosporium delastrei DeLacr. in Mont. (see P. saponariae).

117. Phacidium punctiforme Wallr., Flor. Crypt. Germ. 2: 413 (1833).

The original description does not support a species of Phacidium. It is suggestive of Pyrenopeziza laurocerasi (Desm.) Nannf.

118. Phacidium quadratum Schm., in Kunze & Schmidt, Mycol. Hefte 1: 32: 32 (1817).

The species is referable to Coccomyces leptideus (≡ Phacidium leptideum q.v.).

119. Phacidium quercinum Schw., Trans. Phil. Am. Soc. (New Series) 4: 243 (1832).

See P. delta.

120. Phacidium repandum Fr., K. Vet. Akad. Handl. 40: 108 (1819).
≡ P. repandum Fr.:Fr., Syst. Mycol. 2: 578 (1823).
≡ *Leptotrochila repanda (Fr.:Fr.) Karst., Bidrag. Finlands Natur. Folk 19: 246 (1871).
= P. autumnale Fuckel, Jahrb. Nass. Ver. Naturk. 23/24: 262 (1869/1870).
= P. vernale Fuckel, ibid., pp. 262-263.

See Schueepp (1959) for a complete synonymy and discussion of L. repanda.

121. Phacidium radians Rob., in Desmazières, Ann. Sci. Nat. Bot. 116: (1842).

≡ *Leptotrochila radians (Rob.) Karst., Bidrag Finlands Natur. Folk 19: 245 (1871).

Specimen examined: in FH, Karsten Fungi Fenn. 845, Finland, 1867-X.

See Schueepp (1959) for a complete treatment of this species, which is not a Phacidium, and is now disposed in Leptotrochila (Helotiales).

122. Phacidium ranunculi (Fr.) Lib., Plant. Crypt. Ard. Fasc. 1: 69 (1839).

See Phacidium congener.

123. Phacidium rhododendri Schw., Trans. Am. Phil. Soc. (New Series) 4: 242 (1834).

Specimens examined: in BPI and FH, Isotypes, Schweinitz 2051, Bethlehem, Pennsylvania, U.S.A.

The type material examined was poor, but clearly showed that P. rhododendri was referable to Coccomyces rhododendri (Schw.) Sacc. There seems to be some controversy regarding the application of the name Coccomyces rhododendri (see Sherwood 1980).

124. Phacidium rhytismoideum Cke. & Massee, Grevillea 18: 81 (1890).
≡ *Fabraea rhytismoides (Cke. & Massee) Sacc., Syll. Fung. 10: 50 (1892).

The original description cited the spores as 1-septate, 16-18 X 3-4 um, on leaves of Cotula sp. It seems unlikely that the fungus is a species of Phacidium.

125. Phacidium rubi Fr., Syst. Mycol. 2: 578 (1823).
≡ Coccomyces rubi (Fr.) Karst., Bidrag Finlands Natur. Folk 19: 258 (1871).
= *Coleroa chaetomium (Kze.:Fr.) Rabenh., Herb. Mycol. 1456 (1850).

Specimens examined: in FH, Isotype, Scleromyceti Sueciae 56; Fuckel Fungi Rhenani 1094; in BPI, Isotype, Scleromyceti Sueciae 56, ed. II; Fuckel Fungi Rhenani 1094.

Mueller & Arx (1962) referred P. rubi to Coleroa chaetomium (Dothideales).

126. Phacidium saponariae Ces., in Rabenhorst-Klotzschii Herb. Viv. Mycol. 1728.
≡ *Diplocarpon saponariae (Ces.) Nannf., Svensk. Bot. Tidskr. 30: 297 (1936).

Specimens examined: in FH, Isotype, Herb. Viv. Mycol. 1728; Desmazières Plant. Crypt. France 792 (1860), as Phacidium pumilum.

According to Nannfeldt (1928) the anamorph of D. saponariae is Gloeosporium delastrei (see Phacidium pumilum).

127. Phacidium schizoxylon Fr., Summa Veg. Scand., p. 369 (1849).

Specimen examined: in UPS, Scleromyceti Sueciae 412.

Rehm (1896) believed P. schizoxylon to be referable to Schizoxylon *sepincola* Pers. The material examined contained no such fungus, and the herbarium packet bore an annotation stating that the species was a *Melittosporium*. We could not confirm this. The identity of *P. schizoxylon* remains in doubt.

128. *Phacidium seriatum* Fr., Elench. Fung. 2: 131 (1828).
≡ *Cenangium seriatum* Fr., Syst. Mycol. 2: 185 (1823).
≡ *Godronia seriata* (Fr.) Seaver, Mycologia 37: 345 (1945).
≡ **Durandiella seriata* (Fr.) Groves, Can. J. Bot. 32: 139 (1954).

Specimen examined: in FH, Isotype, Scleromyceti Sueciae 161.

Anamorph: *Gelatinosporium betulinum* Peck.

Groves (1954) referred *P. seriatum* to *Durandiella*. DiCosmo (1978) provided an redescription, elucidated conidiogenesis and illustrated the *Gelatinosporium betulinum* anamorph of *D. seriata*.

129. *Phacidium sieversiae* E. Mueller, Sydowia 12: 207 (1958/1959).
≡ *Odontotrema sieversiae* (Mueller) DiCosmo, Nag Raj & Kendrick
Figs. 459-464.
Can. J. Botany 61: 42 (1983).

P. sieversiae was introduced for "...einen discomycetenartigen Ascomyceten aus der Familie der Phacidiaceae," found on leaves of *Sieversia montana* (Mueller 1958). However, re-examination of the holotype material in ZT clearly shows that *P. sieversiae* is best referred to *Odontotrema*.

Mueller's original description is adequate and need not be repeated here. However, the paraphyses are either simple or branched and invested in mucilage.

130. *Phacidium simulatum* Berk. & Broome, Ann. Mag. Nat. Hist. 3, 7: 451 (1861).
= *Pyrenopeziza lycopi* (Rehm) Rehm, Rabenhorst, Kryptogamen Flora 3(2): 626 (1896).

Both Rehm (1896) and Nannfeldt (1939) placed *P. simulatum* in *Pyrenopeziza*.

131. *Phacidium sparsum* Peck, Bot. Gaz. 6: 35 (1880).

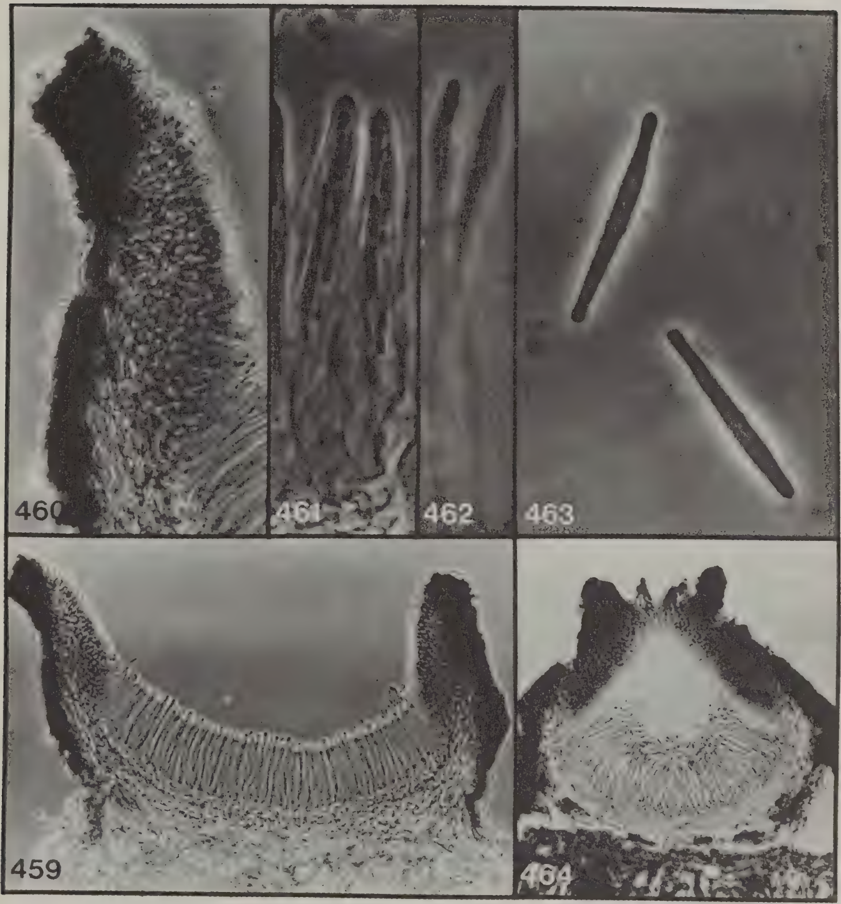
Specimen examined: in FH, Isotype, C. Pringle, Charlotte, Vermont, U.S.A., 1879-XII-12.

The material examined was in poor condition. The immature, stalked ascomata were not characteristic of *Phacidium*.

132. *Phacidium stellatum* Sprengel, Syst. Veg. 4(1): 410 (1827).

Sprengel (1827) introduced *P. stellatum* for *Hysterium globulosum* Pers., and *Actidium hysterioides* Fr. We have not been able to secure type or authentic material of *P. stellatum*, but from the protologue it seems unlikely that it is a *Phacidium*.

133. *Phacidium striatum* Phill. & Plowr., Grevillea 13: 75 (1885).
= *P. peltiforme* Preuss, Linnaea 26: 724 (1853).
= *P. trigonum* Schm., in Kunze & Schmidt, Mycol. Hefte 1: 40 (1817).



Odontotrema sieversiae. 459. V.S. of fully expanded ascoma. x 125. 460. Margin and fungal roof. x 310. 461. Two asci. x 770. 462. Detail of paraphyses in mucilaginous matrix: note the peculiar subapical collar. x 1280. 463. Two ascospores. x 1280. 464. V.S. of an unopened ascoma. x 100.

= *Coccomyces tumidus (Fr.) DeNot., Giorn. Bot. Ital. 2: 38 (1847).

Sherwood (1980) has provided a detailed synonymy and treatment of C. tumidus.

134. Phacidium subantarcticum Spegazzini, Physis 7: 15-16 (1923).

We have examined the type material of P. subantarcticum in LPS 28186 and found perithecial ascomata bearing 1-4-septate ascospores. Most of the ascospores appeared immature. We found only three multicellular spores, 10-15 X 3-4 µm. Spegazzini suspected that the species was not a good Phacidium and we have confirmed his observation.

135. Phacidium symplocinum Sydow, in Syd., Syd. & Butler, Annls. Mycol. 9: 376 (1911).
≡ *Ascluella symplocina (Syd., Syd. & Butler) DiCosmo, Nag Raj & Kendrick
Can. J. Botany 61: 42 (1983).
Figs. 465-469.

Ascomata foliicolous, hypophyllous, scattered, discrete, occurring on bleached spots of the host, at first immersed, subepidermal, ultimately erumpent, circular to subcircular in outline, black, 1000-2000 µm diam., and up to 250 deep, often on a short, stout stipe. Involute margin composed of brown, septate, smooth-walled hyphae forming a textura porrecta which is dense textura intricata which becomes somewhat pseudoparenchymatous toward the base. Hymenium composed of asci and paraphyses resting on a subhymenium of textura intricata, up to 70 µm thick, which is pale yellow-brown below and becomes hyaline toward the hymenium. Asci 8-spored, clavate, 98-110 X 8-11 ($\bar{x}$ = 108 X 9.5) µm, uniformly thick-walled, except for the apical region, dehiscent by a delicate apical pore which is non-amyloid (I^-). Ascospores confined to the upper half of the ascus, uniseriate, subspherical to ellipsoid, hyaline, smooth-walled except for restricted areas bearing longitudinal striae, 6-7.5 X 4-5 ($\bar{x}$ = 7 X 4.5) µm, invested in a mucilaginous matrix, mean length/width ratio = 1.7:1. Paraphyses branched or simple, subcylindrical, septate, hyaline, smooth-walled, up to 120 X 1.5-2 µm, invested in mucilage.

Host: Symplocos sp.

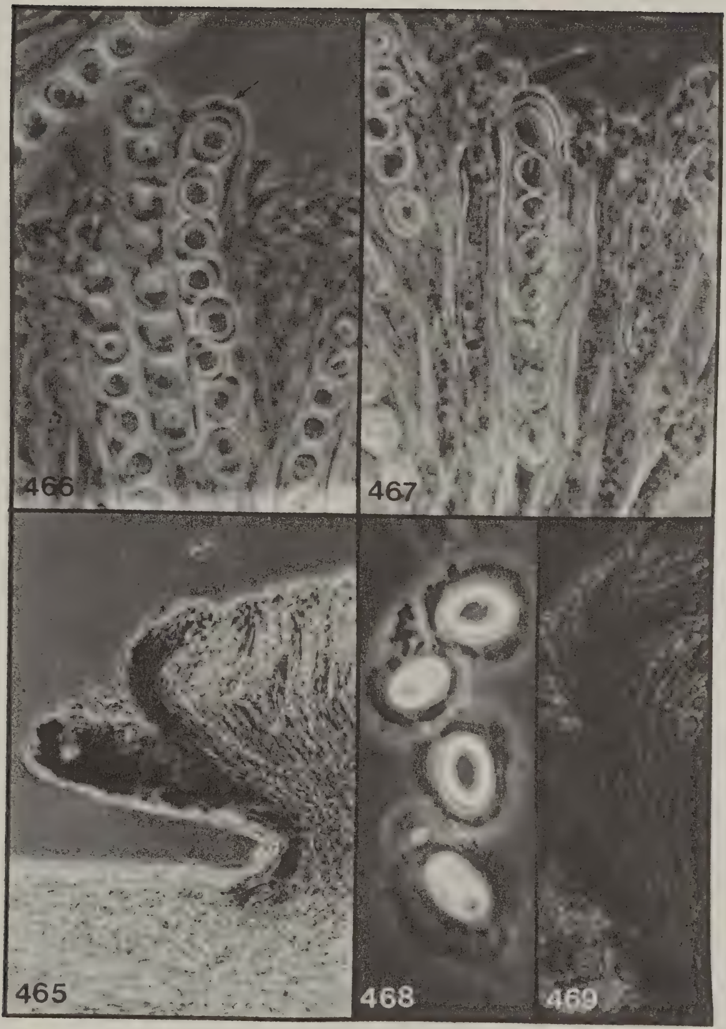
Known distribution: India.

Specimen examined: in S, Holotype, E. J. Butler no. 1341, W. C. McRae, Darjeeling, India, 1909-VII.

DiCosmo et al. (1982) rediposed P. symplocinum in a new genus, Ascluella.

Ascomata of A. symplocina are erumpent and hypophyllous on green leaves. The apothecia develop within a subepidermal stromatic tissue composed of brown, septate, densely compacted hyphae (Fig. 465) on the flanks of the apothecium. The involute margin is composed of brown, septate, smooth-walled hyphae forming a textura porrecta. The ascal apex bears a delicate, non-amyloid (I^-) dehiscence pore (Figs. 466, 467), the ascospores bear longitudinal striae (germ slits?) on restricted areas, and are enveloped in a mucilaginous matrix (Fig. 468). No family of ascomycetes known to us shares these peculiar features. However, we hesitate to erect a new family based on a single collection, so we have retained Ascluella in the Dermateaceae of the Helotiales.

136. Phacidium taxi (Fr.):Fr., Syst. Mycol. 2: 575 (1823).
(sanctioned; ICBN, Art. 13.1(f)).
≡ Xyloma taxi Fr., Obs. Mycol. 1: 201 (1815).
≡ Trochila taxi (Fr.:Fr.) Fr., Summa Veg. Scand. 367 (1849).



Ascluella symplocina. 465. V.S. of margin of ascoma, showing flanking stroma, medullary excipulum and part of hymenium. x 65. 466. Ascus, arrow indicates apical dehiscence mechanism. x 1280. 467. Ascus with ascospores showing striae. x 1280. 468. Ascospores with mucilaginous sheaths. x 2000. 469. Detail of margin of ascoma. x 310.

Specimens examined: in FH, Fuckel Fungi Rhenani 1114; in S, sub P. taxi, Marcucci, Toneri di Seui, Sardinia, 1866-IV; Fuckel Fungi Rhenani 1114, Austria, 1894; Reliquiae herb. Fuckel 758; herb. Sydow, Morthier (no other data); Rabenhorst-Winter Fungi Europaei 3095, Muracucci, Toneri di Seui, Sardinia, 1866-IV; herb. Rehm, Weilheim, 1910-X; Fuckel Fungi Rhenani 1033; specimen on leaves labelled no. 758.

We could not find an ascomycete matching the description of P. taxi on any of the material examined. Rehm (1896) suggested that P. taxi was identical to Sphaeropsis taxi Berk. (≡ Phoma taxi (Berk.) Sacc., Syll. Fung. 3: 102 (1884)). We frequently found a coelomycete indistinguishable from Cryptocline taxicola (All.) Petrak on the collections examined. Nag Raj (1983) discussed P. taxi.

137. Phacidium terrestre Niessl., in Rabenhorst Fungi Europaei no. 1153 (1868).

See Phacidium humigenum.

138. Phacidium tetracerae Rudolf, in Fr., Linnaea 5: 551 (1830).
≡ Coccomyces tetracerae (Rud.) Sacc., Syll. Fung. 8: 748 (1889).
≡ *Hysterostomella tetracerae (Rud.) Hoehn., Sber. Akad. Wiss. Wien 118: 1541 (1909).

139. Phacidium teucrii Crouan, Fl. Finist. p. 42 (1867).

Specimen examined: in UPS, Holotype, Poeppig, Cuba.

This is a bitunicate ascomycete referable to Hysterostomella Spegazzini.

We have not studied the type material of this species. Crouan's specimens are housed in Concarneau and may not usually be borrowed.

140. Phacidium theae N. Antonova, Bot. Matep. 8: 5 (1952).

The original description of P. theae did not include the citation for the holotype, and we have been unable to locate the material. The illustration accompanying the protologue does not suggest Phacidium.

141. Phacidium tini Duby, Bot. Gall. 2: 722 (1830).
≡ Trochila tini (Duby) Quelet, Enchirid. Fung. p. 339 (1886).
≡ *Pyrenopeziza tini (Duby) Nannf., Nova Acta Regiae Soc. Sci. Upsal. IV, 8(2): 162 (1932).

Specimens examined: in FH, Desm. Plant. Crypt. France 993; Mougeot & Nestler 1181; Westendorp & Wallays Herb. Crypt. 920.

This species is a good Pyrenopeziza.

142. Phacidium trifolii (Biv.-Bern.) Bond., Ann. Sci. Nat. Bot. ser. 5, 10: 123 (1869).

Specimens examined: in FH, ex herb. Libert sub P. trifolii, C. Roumeguere, Fungi selecti exs. 660, Reliquiae Libertianae.

See Phacidium medicaginis.

143. Phacidium trigonum Schm., in Kunze & Schmidt, Mycol. Hefte 1: 40 (1817).
= P. peltiforme Preuss, Linnaea 26: 724 (1853).
= P. striatum Phill. & Plowr. Grevillea 13: 75 (1885).

Specimens examined: in FH, Rabenhorst-Winter Fungi Europaei 3363, de Thuemen, Mycotheca universalis 1367.

Sherwood (1980) provided a detailed treatment of this species as *Coccomyces tumidus.

144. Phacidium tsugae Cash & Davidson, Mycologia 32: 732 (1940).
≡ *Korfia tsugae (Cash & Davidson) Reid & Cain, Mycologia 55: 783-784 (1963).

Specimen examined: in BPI, Holotype, E. R. Toole, F.P. 72022, Pincola, N. Carolina, U.S.A., 1938-VI-24.

This species was referred to the Hemiphacidiaceae by Reid & Cain (1963). Their disposition has not been challenged.

145. Phacidium ulceratum (Phill. & Plowr.) Hoehn., Sber. Akad. Wiss. Wien 126: 322 (1917c).

See Phacidium minutulum.

146. Phacidium uleanum Rehm, Hedwigia 39: 80 (1900).

We have referred this species to *Macroderma (Rhytismataceae).

147. Phacidium umbonatum Preuss, Linnaea 26: 724 (1853).
≡ Coccomyces umbonatum (Preuss) Sacc., Syll. Fung. 8: 750 (1889).

We could not locate any authentic or type material of this species. According to Sherwood (1980) it may be Therrya pini.

148. Phacidium vaccinii Fr. var. oxycoccinii Dearn. & House, N.Y. State Mus. Rept. 24: 29 (1940).

See Phacidium oxycoccos.

149. Phacidium vernale Fuckel, Jahrb. Nass. Verb. Naturk. 23/24: 262 (1869/1870).

See Phacidium verrucosum.

150. Phacidium (?) verrucosum (Wallr.) Sacc., Syll. Fung. 8: 717 (1889).
≡ *Leptotrochila verrucosa (Wallr.) Schueepp, Phytopathol. Z. 36: 257 (1959).
= P. autumnale Fuckel, Jahrb. Nass. Ver. Naturk. 23/24: 262 (1869/1870).
= P. vernale Fuckel, ibid.
= P. brunneolum Peck, N.Y. State Mus. Rept. 31: 48 (1879).

Specimens examined: in FH, Klotz. Herb. Mycol. 107; Roumeguère Fung. Gall. exs. 2827; in NYS, Holotype of P. brunneolum, C. H. Peck, Summit, Schoharie County, N.Y., U.S.A.

Schueepp (1959) provided a detailed treatment of *L. verrucosa*. We concur with his disposition of this species.

151. *Phacidium viride* Richon, Champ. Marne 223 (1889).
≡ *Coccomyces viridis* (Rich.) Sacc., Syll. Fung. 10: 51 (1892).

In the original diagnosis, the spores of *P. viride* were described as 40 µm long, and the ascomata occurred on wood of *Populus*. We know of no species of *Phacidium* with such long ascospores. This and the nature of the substrate make it most unlikely that *P. viride* is a *Phacidium*.

152. *Phacidium wallrothii* Rabenhorst, Rabenhorst Herb. Mycol. 1537.

Specimen examined: in FH, Rabenhorst-Klotzschii Herb. Mycol. 1537, Piedmont, 1850.

The material we examined bore a *Leptotrochila*, perhaps *L.* *L. ranunculi*.

153. *Phacidium xylopiae* Henn., Hedwigia 43: 268 (1904).

P. xylopiae was described from leaves of *Xylopia grandiflora* in Peru. The black, carbonaceous ascomata produced 8-spored asci, 80-110 X 23-30 µm, with ellipsoid to subglobose, hyaline ascospores, 13-18 X 12-15 µm. The ascospore measurements suggest that this species is not a *Phacidium*.

It will be difficult to establish the identity of the species with certainty because Dr. Hein of B informed us that Henning's ascomycete collection was destroyed in 1943.

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ENDNOTES

[1] Based on a thesis submitted by the senior author to the University of Waterloo in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Biology.

[2] Present Address: Department of Botany, University of Toronto, Toronto, Ontario, Canada, M5S 1A1.

[3] Hennebert & Bellemere (1979) believed that differences in ascoma development, ascus structure and anamorphs warranted removal of the Rhytismataceae from the Phacidiales. They placed the Rhytismataceae in the Hypodermales sensu Hennebert & Bellemere.

[4] There is active controversy regarding the taxonomic utility of this reaction. Details of rehydration technique and reagents used should always be cited. The reader is referred to Kohn & Korf (1976) and Rossman (1980) for discussions on the varibility of iodine reactions in ascomycetes. The iodine-positive reaction (I^+) we report was consistent and stable in all species of the Phacidiaceae sensu DiCosmo, Nag Raj & Kendrick.

[5] The term 'snow-blight' refers to the defoliation of conifers caused by some fungi treated herein. In certain cases, only those branches and leaves covered by snow during the previous winter show the symptoms: discolouration with subsequent death and defoliation of the affected portions in subsequent years.

[6] The brackets are ours.

[7] Persoon (1801) based his classification on the position of the hymenium. The division into Angiocarpi and Gymnocarpi depended upon whether the fructification was closed or open. Furthermore, the Angiocarpi, were divided into Sclerocarpi with a hard covering, the Sarcocarpi, with a fleshy covering, and the Dermatocarpi, with a membranous covering.

[8] Available from Difco Laboratories, Detroit, Michigan, U.S.A.

[9] "Cryoform" made by Damon/IEC Div., 300 Second Ave., Needham Hts., Mass., 02194, U.S.A. Catalogue No.3383 and available from scientific supply companies.

[10] "Glyceel" manufactured by G. T. Gurr, available from Hopkin & Williams, Chadwell Heath, Essex, England.

[11] Glycerol-Chloral Hydrate Medium: glycerol 100 mL, chloral hydrate 25 g, acid fuchsin 0.1 g, distilled water 25 mL.

[12] Melzer's Reagent: chloral hydrate 100 g, potassium iodide 5 g, iodine 1.5 g, distilled water 100 mL.

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HOST FAMILY-FUNGUS APPENDIX

FAMILY/HOST	FUNGUS
Apocynaceae	
Vinca	*Ceuthospora*
	Phacidium
Aquifoliaceae	
Ilex	*Ceuthospora*
	Phacidium
Araliaceae	
Hedera	*Ceuthospora*
Berberidaceae	
Berberis	*Ceuthospora*
Betulaceae	
Betula	*Ceuthospora*
	Phacidium
Cupressaceae	
Juniperus	*Phacidium*
Ericaceae	
Arbutus	*Apostrasseria*
Gaultheria	*Ceuthospora*
Gaylussacia	*Phacidium*
Ledum	
Rhododendron	
Vaccinium	
Fagaceae	
Quercus	*Ceuthospora*
Leguminosae	
Genista	*Ceuthospora*
	Phacidium
Myrtaceae	
Eucalyptus	*Phacidium*
Pinaceae	
Abies	*Apostrasseria*
Cedrus	*Ceuthospora*
Larix	*Lophophacidium*
Picea	*Phacidium*
Pinus	
Pseudolarix	
Pseudotsuga	
Tsuga	
Pyrolaceae	
Pyrola	*Apostrasseria*
	Ceuthospora

FAMILY/HOST	FUNGUS
Rosaceae	
Prunus *Rubus*	*Apostrasseria* *Ceuthospora* *Phacidium*
Salicaceae	
Populus *Salix*	*Ceuthospora* *Phacidium*
Taxaceae	
Taxus	*Apostrasseria* *Phacidium*
Taxodiaceae	
Sequoia	*Apostrasseria* *Phacidium*

HOST-FUNGUS APPENDIX

HOST	TELEOMORPH	ANAMORPH
Abies		
alba	*Phacidium abietinum*	*Apostrasseria* anam. *P. abietinum*
	P. coniferarum	*Apostrasseria* anam. *P. coniferarum*
balsamea	*P. abietis*	
	P. balsamicola var. *balsamicola*	*Apostrasseria* anam. *P. balsamicola* var. *balsamicola*
	P. infestans	
concolor	*P. abietis*	
excelsa	*P. abietinum*	
grandis	*P. abietis*	
	P. coniferarum	
lasiocarpa	*P. abietinum*	*Apostrasseria* anam. *P. abietinum*
	P. balsamicola var. *boycei*	*Apostrasseria* (?) anam. *P. balsamicola* var. *boycei*
pectinata	*P. abietinum*	*Apostrasseria* anam. *P. abietinum*
	P. cicatricola	*Ceuthospora cicatricola*
Abies sp.	*P. lacerum*	
Arbutus		
menziesii	*P. arbuti*	*Ceuthospora* anam. *P. arbuti*
Berberis		
vulgaris		*C. magellanica*
Betula		
alba	*P. betulinum*	*C. subcorticalis*
Cedrus		
atlantica	*P. coniferarum*	*Apostrasseria* anam. *P. coniferarum*
deodara	*P. coniferarum*	*Apostrasseria* anam. *P. coniferarum*
libanensis	*P. coniferarum*	*Apostrasseria* anam. *P. coniferarum*
Eucalyptus sp.	*P. eucalypti*	
Gaultheria		
procumbens	*P. lunatum*	*Apostrasseria* anam. *P. lunatum*
shallon	*P. sherwoodiae*	*Ceuthospora* anam. *P. sherwoodiae*
Gaylussacia		
brachycera		*Apostrasseria lunata* anam. *P. lunatum*
Genista		
sagittalis	*P. vincae*	*C. foliicola* anam. *P. vincae*
Hedera sp.		*C. foliicola* anam. *P. vincae*

HOST	TELEOMORPH	ANAMORPH
Ilex		
aquifolium	*P. aquifolii*	*Ceuthospora* anam. *P. aquifolii*
	P. multivalve	*C. phacidioides* anam. *P. multivalve*
glabra	*P. sphaeroideum*	
Juniperus		
chilensis	*P. infestans*	
sabina	*P. infestans*	
Juniperus sp.	*P. infestans*	
	P. lacerum	
Larix		
decidua	*P. coniferarum*	*Apostrasseria* anam. *P. coniferarum*
	P. gaeumannii	*Ceuthospora* anam. *P. gaeumannii*
leptolepis	*P. coniferarum*	*Apostrasseria* anam. *P. coniferarum*
occidentalis	*P. coniferarum*	*Apostrasseria* anam. *P. coniferarum*
russica	*P. coniferarum*	*Apostrasseria* anam. *P. coniferarum*
Larix sp.	*P. abietinum*	
Ledum		
groenlandicum	*P. grande*	
palustre	*P. vestergrenii*	
Picea		
abies	*Lophophacidium hyperboreum*	
	P. coniferarum	
	P. infestans	
canadensis	*P..infestans*	
glauca	*L. hyperboreum*	
mariana	*L. hyperboreum*	
	P. infestans	
rubens	*P. infestans*	
rubra	*L. hyperboreum*	
schrenkiana	*L. hyperboreum*	
Pinus		
banksiana	*P. coniferarum*	*Apostrasseria* anam. *P. coniferarum*
canariensis	*P. coniferarum*	*Apostrasseria* anam. *P. coniferarum*
cembra	*P. infestans*	
	P. pini-cembrae	

HOST	TELEOMORPH	ANAMORPH
contorta	P. coniferarum	Apostrasseria anam. P. coniferarum
mugo	P. coniferarum	Apostrasseria anam. P. coniferarum
mugo var. rostrata	P. infestans	
muricata	P. coniferarum	Apostrasseria anam. P. coniferarum
nigra	P. infestans P. lacerum	Apostrasseria anam. P. coniferarum
piceae	P. abietinum	
radiata	P. coniferarum P. pini-cembrae	Apostrasseria anam. P. coniferarum
sibirica	P. pini-cembrae	
strobus	P. coniferarum	Apostrasseria anam. P. coniferarum
sylvestris	P. coniferarum P. infestans P. lacerum	Apostrasseria anam. P. coniferarum
taeda		C. pinastri anam. P. lacerum
Pinus sp.		Apostrasseria sp.
Populus sp.		C. foliicola anam. P. vincae
Prunus sp.		C. foliicola anam. P. vincae
Pseudolarix amabilis	P. coniferarum	
Pseudotsuga douglasii	P. coniferarum	
glauca	P. coniferarum	
menziesii	P. abietis P. coniferarum P. lacerum P. pini-cembrae	
Pyrola rotundifolia		Apostrasseria sp. C. pyrolae
Quercus sp.		C. foliicola anam. P. vincae
Rhododendron baetici	P. multivalve	C. phacidioides anam. P. multivalve
Rubus fruticosus	P. pusillum	Apostrasseria anam. P. pusillum

HOST	TELEOMORPH	ANAMORPH
Salix		
caprea	*P. salicinum*	*C. salicina* anam. *P. salicinum*
Sequoia		
gigantea	*P. coniferarum*	*Apostrasseria* anam. *P. coniferarum*
wellingtonia	*P. coniferarum*	*Apostrasseria* anam. *P. coniferarum*
Taxus		
brevifolia	*P. dearnessii*	*Apostrasseria robusta* anam. *P. dearnessii*
canadensis	*P. taxicola*	*Apostrasseria fusiformis* anam. *P. taxicola*
Tsuga		
canadensis	*P. coniferarum*	
heterophylla	*P. coniferarum*	
Vaccinium		
macrocarpum		*Apostrasseria lunata* anam. *P. lunatum*
maderense		*Ceuthospora* sp.
vitis-idaea	*P. vaccinii*	*C. latitans* anam. *P. vaccinii*
Vinca		
minor	*P. vincae*	*C. foliicola* anam. *P. vincae*

ABBREVIATIONS FOR HERBARIA

B: Botanisches Garten und Museum Berlin-Dahlem, Königin-Liuse Strasse 6-8, D-1 Berlin 33 (Dahlem), Germany BRD.
BPI: The National Fungus Collections, United States Department of Agriculture, Room 313, Bldg 011A, BARC-West, Beltville, MD 20705, U.S.A.
DAOM: National Mycological Herbarium, Biosystematics Research Institute, Canada Agriculture, Central Experimental Farm, Ottawa, Ontario, K1A OC6, Canada.
FH: Farlow Herbarium and Reference Library, Harvard University, 20 Divinity Avenue, Cambridge, Massachusetts 02138, U.S.A.
G: Conservatoire et Jardin Botanique, 192 route de Lausanne, Geneve, Switzerland.
H: Botanical Museum, University of Helsinki, Unioninkatu 44, SF-00170 Helsinki Finland.
ILLS: Illinois State Natural History Survey, Natural Resources Building, Urbana, Illinois, U.S.A.
IMI: Commonwealth Mycological Institute, Ferry Lane, Kew, Richmond, Surrey TW9 3AF, England.
K: The Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AE, England.
LPS: Instituto de Botanica C. Spegazzini, Calle 53 no. 477, La Plata, Bs. As., Argentina.
NY: The New York Botancial Garden, Bronx Park, New York, New York 10458, U.S.A.
NYS: Herbarium, New York State Museum, Albany, New York 12201, U.S.A.
PAD: Instituto di Botanica e Fisiologia Vegetale, Universita di Padova, Via Orto Botanico 15, 35100 Padova, Italy.
S: Botanical Department, Naturhistoriska Riksmuseet, S-104 05 Stockholm, Sweden.
TRTC: Department of Botany, University of Toronto, Toronto, Ontario M5S 1A1, Canada.
UPS: Institute of Systematic Botany, The University, P.O. Box 541, S-751 21 Uppsala, Sweden.
WAT: Mycology Laboratory, Department of Biology, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada.
Z: Botanischer Garten und Institut für Systematische Botanik der Universtität, 40 Pelikanstrasse, Zürich, Switzerland.
ZT: Institut für Specielle Botanik, Eidgenossische Technischen Hochschule, Universitätsstrasse 2, CH-8006 Zürich, Switzerland.

INDEX OF FUNGAL TAXA

BOLDFACE = **ILLUSTRATION**
UNDERLINE = DESCRIPTION

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MELOPHIA OPHIOSPORA (LEV.) SACC., *MUTATIS CHARACTERIBUS*, CHAMPIGNON PHELLOPHAGE SUR LE CHÊNE-LIÈGE,

par E.O. SPEER *

SUMMARY

The description of the microfungus *Melophia ophiospora* (Lév.) Sacc. (Sphaeropsidales) is revised and a *neotypus* is declared. It has been found that its conidia can be bicellular as well as unicellular. For the first time, microconidia have been observed. The fungus has been collected in several new areas. For the fungus ability to attack cork-cells, the term "phellophagy" is introduced.

⁂

Jusqu'à une date récente **(Speer, 1981)**, *Melophia ophiospora* (Lév.) Sacc. n'était connu que dans le midi de la France et en Corse **(Léveillé, 1848)**. Malheureusement, il semble que le matériel type de Léveillé n'existe plus et que l'on n'a pas retrouvé le champignon depuis. Nous déclarons donc notre spécimen corse comme *neotypus*. Nous avons trouvé le champignon dans d'autres régions méditerranéennes et dans la région atlantique, comme le montre l'énumération des stations d'où provient le matériel étudié. (Tous les spécimens font partie de notre collection ; l'échantillon " *neotypus* " est au Muséum National d'Histoire Naturelle, Paris).

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1. **France :**
   - Corse, près de Casatorra, septembre 1977 (*neotypus*) ;
   - Hérault, près de Saint-Martin-de-Londres, mai 1978 ;
   - Landes, près de Capbreton, juillet 1978.

2. **Espagne :**
   - Cáceres, près de Mohedas, juin 1978 ;
   - Cáceres, près de Santa Elena, juin 1978.

3. **Portugal :**
   - Algarve, près de Albufeira, juillet 1978 ;
   - Algarve, près de Craveirao, juillet 1978 ;
   - Baixo Alentejo, près de Marateca, juillet 1978.

4. **Maroc :**
   - Forêt de Mâmora, près de Rabat, avril 1981.

⁂

La description originale, qui ne comporte pas d'illustration **(Léveillé, 1848, cf.*)**, étant inexacte pour un certain nombre de points essentiels, il nous a paru nécessaire de la préciser, surtout en ce qui concerne la consistance des pycnides, la couleur de leur contenu, la bicellularité des conidies et l'existence de microconidies. Remarquons que **Saccardo (1884)** s'est contenté de reprendre la description de Léveillé.

Le champignon provoque des lésions sur les lèvres, normalement assez lisses, des fissures naturelles de l'écorce. Ces lésions, de plus ou moins grandes dimensions, se présentent sous la forme de petites dépressions ou de petits trous, groupés ou en ligne, où se localisent les fructifications du champignon, visibles sous l'aspect de points noirs de taille variable **(Planche I, fig. 1)**.

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* *Conceptaculis gregariis subseriatis adnatis basi applanatis convexis, laevibus, demum depressis corrugatis, intus extusque nigris; sporis continuis utrinque obtusis curvatis vel serpentiformibus.*

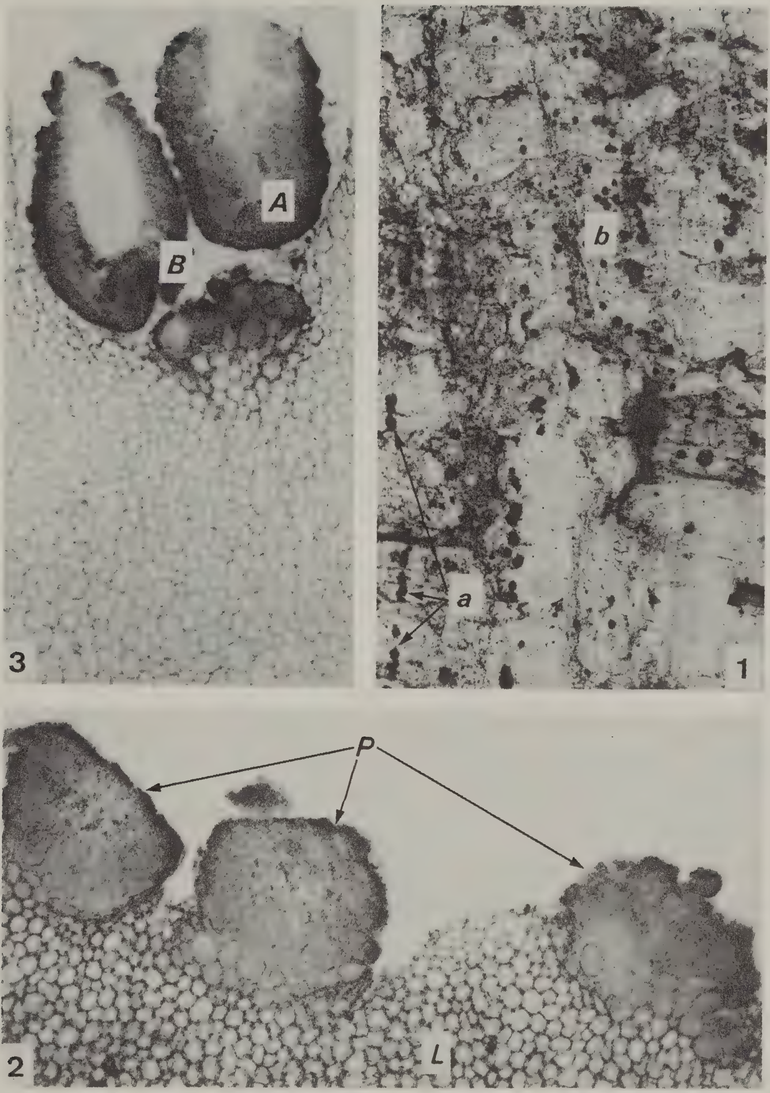

Planche I.
Melophia ophiospora sur l'écorce de *Quercus suber*.
Fig. 1. Pycnides dispersées en ligne (a) ou groupées (b) (gr. env. x4).
Fig. 2. Coupe longitudinale de jeunes pycnides (P) sur des cellules de liège (L) (gr. env. x100).
Fig. 3. Coupe longitudinale de deux pycnides qui produisent des microconidies (A) et des macroconidies (B) (gr. env. x100).

Bien que *Melophia ophiospora* se développe sur une matière première aussi importante que le liège de *Quercus suber* L., sa biologie n'a été étudiée que récemment **(Speer, 1981)**. Sur les coupes histologiques, nous voyons que les hyphes du champignon n'attaquent que les cellules subérifiées de l'écorce, propriété que nous avons qualifiée de "phellophagie".

Seules les macroconidies étaient connues jusqu'ici. Nous avons pu également observer la production de microconidies.

Les pycnides, génératrices de conidies, se différencient de manière schizogène dans un stroma basal. D'abord plus ou moins sphériques, elles peuvent, à maturité, présenter des formes variables, plus ou moins allongées ou aplaties **(Planche I, fig. 2 et 3)**.

Ces pycnides, coriaces et cassantes, sont de consistance assez dure. Leur taille est très variable et peut atteindre un diamètre de 300 µm environ. leur sommet saillant, plat ou déprimé, s'ouvre par une fente de déhiscence irrégulière, dont les bords peuvent s'ouvrir largement. La partie externe de la paroi limitant la fructification est formée de cellules isodiamétriques et pigmentées, tandis que la partie interne montre des cellules plates et hyalines. La couche fertile qui recouvre toute la cavité est, dans sa partie basale, souvent lacuneuse.

Les macroconidies se forment de manière holoblastique, au sommet de conidiophores comportant de une à trois cellules **(Planche II, fig. 3 et 4)**. Elles sont hyalines, généralement unicellulaires, plus rarement bicellulaires, falciformes ou serpentiformes **(Planche II, fig. 5 à 7)**.

Toutefois, avant la formation des macroconidies, les mêmes pycnides peuvent produire des microconidies. Celles-ci naissent également de façon acrogène sur des conidiophores, mais ces

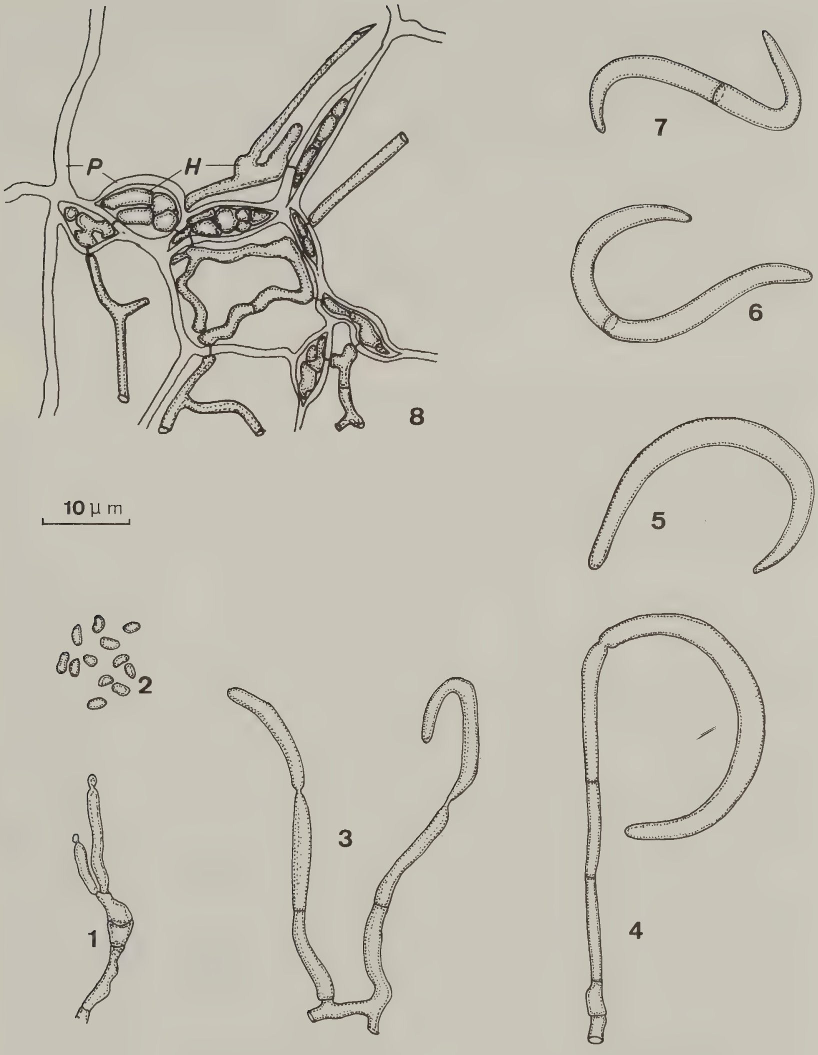

Planche II.
Melophia ophiospora.
Fig. 1. Microconidiophore.
Fig. 2. Microconidies.
Fig. 3. Conidiophores avec jeunes macroconidies.
Fig. 4. Conidiophore avec macroconidie.
Fig. 5 à 7. Macroconidies mûres.
Fig. 8. Hyphes mycéliennes (H) entre et dans les cellules du liège (P = parois subérifiées).

derniers, généralement ramifiés, sont plus courts que ceux générateurs de macroconidies **(Planche II, fig. 1)**. Les microconidies, hyalines, elliptiques ou réniformes, mesurent 1 µm de large et 2 à 3 µm de long **(Planche II, fig. 2)**. N'ayant pu observer d'hyphes réceptrices, nous ne pouvons donc leur attribuer un rôle éventuel de spermaties.

L'ensemble de ces éléments nouveaux amène à réformer la diagnose originale du champignon, et nous proposons en conséquence, la formulation suivante :

Descriptio emendata :

Melophia ophiospora (Lev.) Sacc. *in Syll. Fung.* 3: 659. 1884.
Basionym : *Melasmia ophiospora* Lév. *in* **Ann. Sci.** Nat. IIIe sér., 9 : 253. avr. 1848.

Mycelium hyalinum vel brunneum substratum intra- et intercellulariter penetrans. Pycnidia singularia, dispersa vel lineis aggregata, substrato insidentia, globosa, mox plus minusve depressa, apice irregulariter dehiscentia. Hymenium hyalinum, aut globosum, aut basaliter lacunosum. Conidiophora uni- vel pluricellulata, ad 25 µm metientia. Conidia blastosporarum modo acrogena, hyalina, aut simplicia et falcata, aut uniseptata et sigmoïdea, 45 - 55 x *2 - 3 µm. Microconidia in eisdem pycnidiis antehac nascuntur, ellipsoïdea vel fabiformia, 1* x *2 - 3 µm, singula acrogena in hyphis tenuibus late patentibus.*
Habitat in cortice Quercus suberis L. *vivi. Nobis legebatur prope Casatorra, Corsica, 3 septembro 1977. Neotypus : PC, et in mycotheca nostra.*

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MERULIUS, A SYNONYM OF PHLEBIA

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ABSTRACT

Merulius Fr. is placed in synonymy with Phlebia Fr. Supporting evidence from basidiocarp and culture studies are presented. The new combinations Phlebia tremellosus and Phlebia incarnata are proposed.
Keywords: Merulius, Merulius tremellosus, Phlebia, Phlebia radiata

INTRODUCTION

The similarities and close relationships between Merulius Fr. and Phlebia Fr., as represented by the type species M. tremellosus Schrad.: Fr. and P. radiata Fr., are widely recognized (Parmasto, 1968; Ginns, 1976; Eriksson and Ryvarden, 1976). We, also, have noted the similarities. The genera are maintained separately, but included in the same family--Corticiaceae--and the same subfamily--Phlebioideae (Parmasto, 1968, p. 89). Jülich (1982), however, considers Merulius and Phlebia as types of different families.

The name Phlebia was proposed by Fries (1821), and he later designated P. radiata Fr. as the type species (1828). When he described the Phlebia, Fries included among the four species P. merismoides Fr., which he had described in 1818 (Table I). This species is often considered to be conspecific with P. radiata and is an earlier name. However, P. merismoides has not been used recently, while P. radiata has been generally accepted for the taxon for the past 30 years. To avoid confusion and unnecessary name changes, we prefer to conserve current usage by recognizing P. radiata and place P. merismoides in synonomy.

The name Merulius has a longer and more complex history. It was used in the sense of Morchella and of Cantharellus (Donk, 1958) before being validated by Fries (1821) in a different sense. Merulius tremellosus is generally accepted as the lectotype species. Recent concepts of Merulius are more restrictive than Fries's and result in more natural groupings. In fact, current concepts retain only one of Fries's original taxa in Merulius (Table I).

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[1] Maintained in cooperation with the University of Wisconsin.

TABLE I

Disposition of taxa in *Phlebia* and *Merulius* accepted by Fries in 1821.

Taxa accepted by Fries	Current status
Phlebia merismoides Fr.	= *Phlebia radiata* Fr.
P. radiata Fr.	nomenclatural type of *Phlebia*
P. contorta Fr.	= *P. radiata* Fr.
P. vaga Fr.	≡ *Trechispora vaga* (Fr.) Liberta
Merulius tremellosus Schrad.: Fr.	nomenclatural type of *Merulius*
M. rufus Fr.	≡ *Phlebia rufa* (Fr.) M. P. Christ.
M. serpens Fr.	≡ *Ceraceomyces serpens* (Fr.) Ginns
M. crispatus Fr.	= *C. serpens*
M. fugax Fr.	= nomen dubium[1]
M. lacrimans Wulf.: Fr.	≡ *Serpula lacrimans* (Wulf.: Fr.) S. F. Gray
M. vastator Fr.	= *S. lacrimans*
M. molluscus Fr.	≡ *Leucogyrophana mollusca* (Fr.) Pouz.
M. himantioides Fr.	≡ *Serpula himantioides* (Fr.) Bond.
M. porinoides Fr.	= *C. serpens*

[1] See Eriksson and Ryvarden (1976, p. 821); Ginns (1978, p. 1970).

Descriptions of basidiocarps and cultures of the two type species are readily available (Ginns, 1976; Eriksson and Ryvarden, 1976; Eriksson et al., 1981). Because our data agree with the published descriptions, we refer the reader to those accounts. Our intention is to analyze and discuss the significant similarities and differences between the two species. The data here support our conclusion that *Phlebia* and *Merulius* are congeneric.

GENERAL OBSERVATIONS

Basidiocarp observations.--Basidiocarps of *P. radiata* and *M. tremellosus* are readily distinguishable. *Phlebia radiata* is entirely effuse although the margins are loosely attached and often can be pulled away from the substrate. The hymenophore is tuberculate and rarely develops either small pits or anastomosing ridges. *Merulius tremellosus* is effuse-reflexed with a radially arranged, pitted hymenophore.

Eriksson and Ryvarden (1976, p. 863) and Jülich (1982, p. 176, 178) maintain the genera are distinct because of the "dimorphic trama" in *Merulius*. Ginns (1976, pp. 139, 153), however, found this character to be present in both species. We concur with his findings.

Several microscopic characters of these species are similar: thickening subhymenium, brownish-orange granular to amorphous material in the hymenium and subhymenium, cystidia, narrowly clavate basidia, and smooth, cylindrical basidiospores. However, there are some differences. Ginns (1976, p. 102) reports that the basidia in M. tremellosus arise sympodially while in P. radiata they are cyme-like. We observed, however, that the basidia in P. radiata and M. tremellosus are produced from sympodially branched hyphae (also see Figs. 432, 589, and 590 in Corticiaceae of North Europe (Eriksson and Ryvarden, 1976; Eriksson et al., 1981)). In addition the subiculum in P. radiata also develops densely staining, broad hyphae that originate in the margins as cylindrical to clavate hyphal end cells. These hyphal end cells are morphologically similar to the cystidia of the subhymenium and hymenium. They are not found in the subiculum of M. tremellosus. The cystidia in P. radiata never protrude beyond the hymenium and are larger than those in M. tremellosus, which protrude slightly above the basidia. However, we interpret these differences to be important only at the species level.

TABLE II

Growth characters of Phlebia radiata and Merulius tremellosus after 1 week incubation on three standard media.

Characteristic	P. radiata	M. tremellosus
Growth on 2% MEA[1] (mm diam)	(82-)90+	(32-)46-77(-90+)
Reaction on 0.5% GAA[2]	+++ to ++++[4]	++
Growth on 0.5% GAA (mm diam)	(0-)23-50	50-85
Reaction on 0.5% TAA[3]	++++	++++
Growth on 0.5% TAA (mm diam)	20-35	25-33

[1] Malt extract agar.
[2] Gallic acid agar.
[3] Tannic acid agar.
[4] ++, weak; +++, moderate; ++++, strong.

TABLE III

Summary of some significant microscopic cultural characters of P. radiata and M. tremellosus.

Characters	P. radiata	M. tremellosus
Vegetative cystidia	present	absent
Chlamydospores	absent	present
Arthroconidia	present/absent	absent

Cultural and other observations.--Whereas *P. radiata* grows rapidly on malt extract agar, the growth rate of *M. tremellosus* is variable. Both species react strongly and grow substantially on gallic acid and tannic acid agars (Table II). The advancing zone hyphae in both species are simple-septate, but later clamp connections develop on all other hyphae. This combination of characters places these species in a unique group of fungi, Group 54 of Nobles (1958). This group of fungi includes most true *Phlebia* species, as well as *Mycoacia fuscoatra* (Fr.: Fr.) Donk, *Hyphodontia setulosa* (Berk. et Curt.) Maas G., *Poria cinerascens* (Bres.) Sacc. et Syd., *Poria rivulosa* (Berk. et Curt.) Cke., and *Poria subvermispora* Pilát.

Although *P. radiata* and *M. tremellosus* can be easily differentiated microscopically in culture (Table III), we contend that the presence or absence of cystidia or asexual spores are important only at the species level. Additionally, both species are associated with a white-rot decay of logs and slash and possess a bipolar incompatibility system (Boidin, 1956; Ginns, 1976; and our results).

Specimens examined: As *Phlebia radiata*: Sweden--Smole: Femsjö, E. Fries, 2 specimens; Femsjö [på bark av *Fagus sylvatica*], herb. E. Fries, 2 specimens, (one is designated NEOTYPE, here selected, of *Phlebia radiata*) (University of Uppsala--UPS). As *Merulius tremellosus*: Sweden--Uppsala, Halmbyboda, E. P. Fries, 1853; Lundell 5650, on *Betula*, Småland, Femsjö; Fungi Suecici, Lundell 4100, on *Fagus*; Femsjö, Fung. exsic. Suecici 249, frondose trees, Hofgärden (UPS).

CONCLUSIONS

Phlebia and *Merulius* traditionally have been maintained as distinct primarily because of the basidiocarp habit and the configuration of the hymenophore. We contend that these characters are not sufficiently important to delimit taxa at the generic level. *Phlebia* and *Merulius* are so similar morphologically and biologically that recognizing them as distinct genera is unwarranted. The cultural and basidiocarp differences observed are important only at the species level.

Because we consider *Merulius* and *Phlebia* congeneric, one of the names must be chosen to represent the genus. Either name could be chosen because both were published by Fries (1821) in the same work, and page priority is not recognized by the International Code of Botanical Nomenclature (Voss et al., 1983). The decision was straightforward for us, considering the following facts: 1) If *Merulius* is placed in synonymy with *Phlebia*, only two new combinations will be required. 2) If *Phlebia* is placed in synonymy under *Merulius*, nearly 50 new combinations will be required. 3) There is good material of *P. radiata* to serve as neotype. Thus, we propose to recognize *Phlebia* and place *Merulius* in synonymy.

Phlebia Fr. emend.: Fruitbody effuse to effuse-reflex or dimidiate, cartilaginous, subgelatinous or ceraceous; hymenophore smooth to hydnaceous or merulioid; hyphal system monomitic; subiculum compact to tightly agglutinated, sometimes dimorphic with loosely interwoven hyphae near substrate, reflexed abhymenial layer also of loosely interwoven hyphae; subicular hyphae hyaline, thin- to thick-walled, usually nodose septate, with or without a gelatinous matrix;

subhymenium thickening; cystidia absent or present, then smooth or encrusted; basidia narrowly clavate, in a dense palisade; basidiospores hyaline, smooth, thin-walled, ellipsoid to allantoid, nonamyloid, acyanophilous.

Neotype: *Phlebia radiata* på bark av *Fagus sylvatica*, Femsjö (herb. E. Fries, UPS).

The following new combinations are required: *Phlebia tremellosus* (Schrad.: Fr.) Nakas. et Burds., comb. nov. (Basionym--*Merulius tremellosus* Schrad.: Fr., Syst. Mycol. 1:327. 1821) and *Phlebia incarnata* (Schw.) Nakas. et Burds., comb. nov. (Basionym--*Merulius incarnatus* Schw., Nat. Ges. Leipzig Schr. 1:92. 1822).

The choice of a neotype specimen to represent *P. radiata* was difficult. Four specimens of *P. radiata* were available from the Fries herbarium, but none agreed entirely with data from the original description. All were collected in Femsjö and labeled in Fries's handwriting, but only two labels indicated that he was the collector. None of the specimens had a substrate stated on the original label, although two specimens were annotated later by Fries as occuring on *Fagus sylvatica*. We have chosen one of the specimens on *Fagus sylvatica* (annotated "Designated Neotype, HHB & KKN") as the neotype, for the following reasons:

1) The neotype is on *Fagus* which differs from Fries's original diagnosis, which states it occurs on *Betula*. Later, however, in the Elenchus Fungorum (Fries, 1828), he indicated *P. radiata* occurs on *Fagus* also. *Phlebia radiata* occurs on many genera of hardwood trees, so the substrate is not critical to the species concept.
2) The morphological characters of the neotype specimen agree with the original description and the neotype specimen is in good condition. The other three specimens cited (in *Specimens Examined*) appear to be portions of the same collection as the neotype.
3) Fries had actually seen and identified this specimen.
4) The current species concept will be maintained.

Merulius tremellosus also lacks a type specimen. Thus, we searched for an appropriate specimen to serve as neotype. None of the specimens obtained from UPS were available to Fries when he described the species. Only one specimen (collected by E. P. Fries in 1853) could have been considered by Fries to be included in any of his publications. Unfortunately, it is inadequate to serve as a neotype. Therefore, we here designate the specimen labeled "Fungi Suecici 4100, *Merulius tremellosus* Schrad. ex Fr., på murken bokstubbe, Sm. Femsjö sn, Hägnen 21.IX. 1940. leg. Seth Lundell" (UPS) as the neotype of *Merulius tremellosus* Schrad.: Fr. This specimen is of adequate size and is in excellent condition. It was collected in Femsjö where Fries commonly collected, so is probably the concept he recognized. It agrees with the currently accepted concept of the species.

ACKNOWLEDGMENTS

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A NEW SPECIES OF SCEDOSPORIUM ASSOCIATED WITH OSTEOMYELITIS IN HUMANS

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SUMMARY

A previously undescribed species of *Scedosporium* was isolated in axenic culture from a human bone biopsy specimen. It differs from other members of this genus in having basally swollen (inflated), flask-shaped conidiogenous cells and slower colony development on nutrient agar media. While members of the genus *Scedosporium* strongly resemble those of *Scopulariopsis*, they can be distinguished by their production of conidia in wet masses at the apices of coarse annellides.

INTRODUCTION

One of us (IFS) recently received a culture of a hyphomycete which had been isolated from a bone biopsy specimen from a 6-year-old boy. Although similar in many respects to the well-known pathogen *Scedosporium apiospermum* (Sacc.) Castellani & Chalmers, the organism is sufficiently different to warrant its description as a new species.

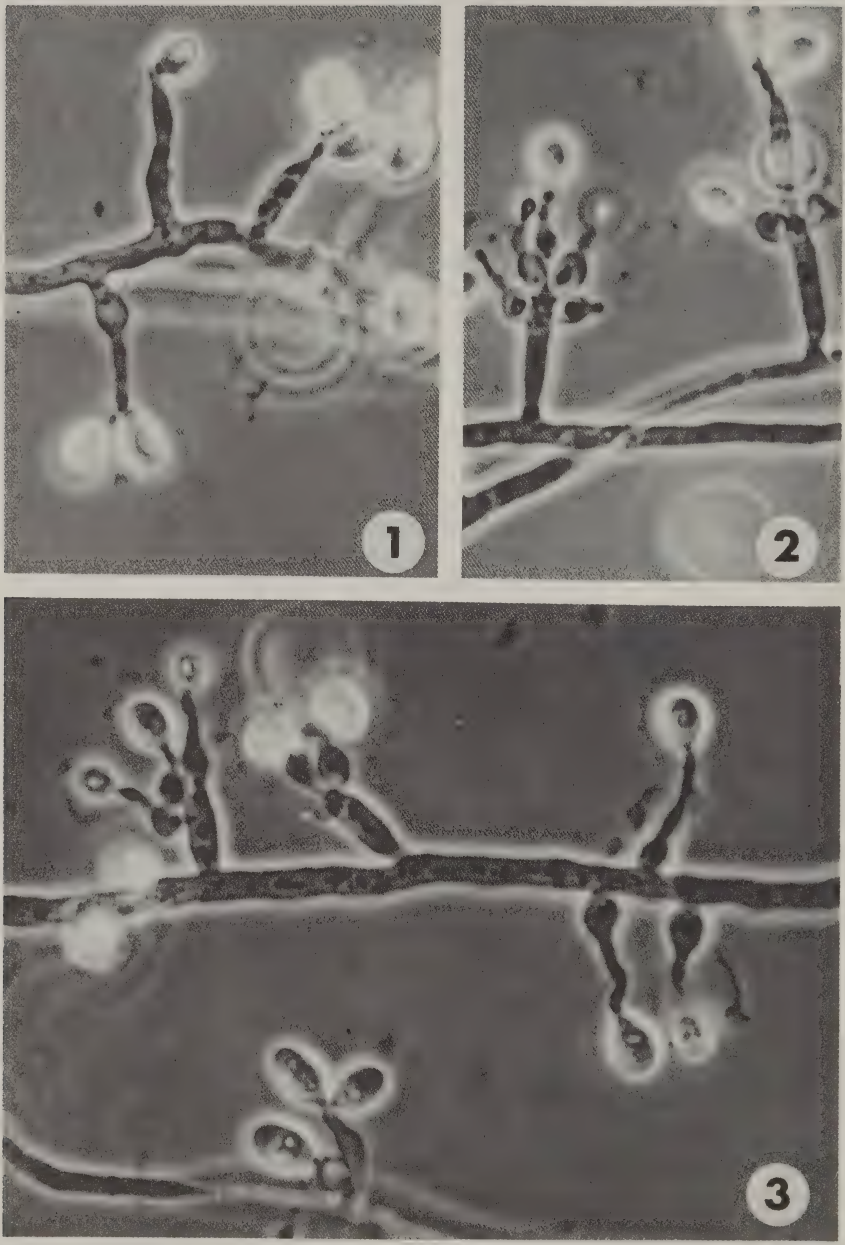

Fig. 1-3. Fig. 1. Solitary conidiogenous cells of *Scedosporium inflatum*, CC222 (TRTC). Fig. 2. Clustered *S. inflatum* conidiogenous cells. Fig. 3. Mixed solitary and clustered conidiogenous cells on same hypha of *S. inflatum*. (All figures X 1500).

TAXONOMY

Scedosporium inflatum Malloch & Salkin, sp. nov. (Figs. 1-5).

Hyphae hyalinae vel brunneae, laeves, septatae, 0.8-3.0 µm crassae. Conidiophora hyalina vel pallide brunnea, simplicia, aseptata, aut raro uniseptata, ad apicem cellulae conidiogerae gerentia. Cellulae conidiogerae fasiculatae vel solitariae, versus basin inflatae, ad apicem irregulariter cylindraceae, 4.9-26 X 2.0-4.0 µm. Conidia hyalina vel olivacea, ovoidea, 5.4-8.1 X 3.5-5.6 µm magna, laevia, ad basin truncata, ad apicem cellulae conidiogerae percurrentes producentia, in massae humidae deposita.

HOLOTYPUS: CC222; In colonia sicca conservata est, e osteomyelite human segregata, Farmington, Maine, U.S.A. In Cryptogamic Herbarium, University of Toronto (TRTC).

VEGETATIVE HYPHAE hyaline to light brown, smooth, branched, remotely to closely septate, frequently anastomosing, 0.8-3.0 µm in diam; CONIDIOPHORES hyaline to brownish, unbranched, aseptate or rarely with a single septum, usually bearing conidiogenous cells at the apex but occasionally also laterally, extremely variable in length; CONIDIOGENOUS CELLS produced singly along the vegetative hyphae or in clusters of 2-6 at the ends of the conidophores, usually distinctly flask-shaped and swollen at base, with neck elongating irregularly as the conidia are produced, 4.9-26 X 2.0-4.0 µm, with swollen base 3.7-22 µm long; CONIDIA nearly hyaline to olivaceous in mass, ovoid 5.4-8.1 X 3.5-5.6 µm (mean = 6.5 X 4.6: standard deviation = 0.57 X 0.46), smooth, truncate at base, fairly thin-walled, produced serially and percurrently or more rarely sympodially at the apex of the conidiogenous cells, collecting in wet masses, never catenulate.

COLONIES on modified Leonian's medium (Malloch, 1981) attaining a diameter of 54 mm in 23 d at 20°C, arachnoid to lanose, with sparse aerial mycelium toward the margin, with aerial mycelium ashy gray over the Olive Brown (4F3-5; Kornerup and Wanscher, 1978) submerged mycelium, with clear droplets among the aerial hyphae, very abundant but apparent only on magnification; reverse Yellowish Gray (3F2) and grading out to Olive (3F3-5) outer areas,

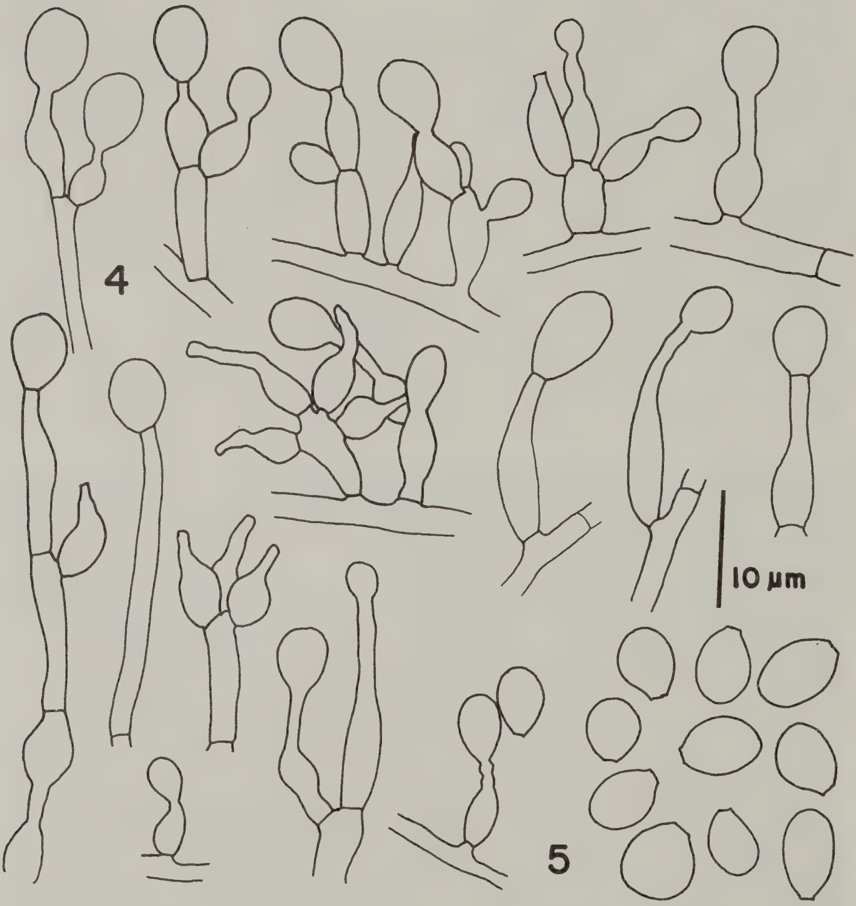

Fig. 4-5. Fig. 4. Conidiogenous cells of *Scedosporium inflatum*. Fig. 5. Conidia of *S. inflatum*.

Grayish Yellow (3B3) at the immediate margin.

COLONIES on Weitzman and Silva-Hutner's medium (Weitzman and Silva-Hutner, 1967) attaining a diameter of 47-55 mm in 23 d at 20°C, lanose and with rather dense aerial mycelium, showing inconspicuous but abundant clear drops as on Leonian's medium but also with some larger ones, Grayish Brown (8E3) at the center, Grayish Brown (5E3) toward the margin, and Greenish Gray (25CD2) at the margin; reverse Greenish Gray to Dark Gray (25D1-2) but with these colors difficult to assess because of the opacity of the medium.

COLONIES on Sabouraud's dextrose medium (Difco) attaining a diameter of 40 mm in 21 d at 20°C, cottony and white in the central 25 mm, arachnoid over an Olive (1-2F3-4) substrate mycelium toward the margin, nearly hyaline in the marginal 2-3 mm, dry in appearance, showing numerous minute clear drops embedded in the aerial mycelium when viewed with a dissecting microscope; reverse mostly Greenish Gray to Dark Green (29-30F2-4), with an area of Grayish Green to Greenish Gray (29-30D2-3) surrounding the center and at the margin, radially cracked at the center.

Holotype: CC222. Isolated from bone biopsy specimen from a case of human osteomyelitis, Farmington, Maine, U.S.A., September 1981. Preserved in the Cryptogamic Herbarium, University of Toronto (TRTC) as a dried culture.

DISCUSSION

Scedosporium inflatum may be compared to several other *Scedosporium* species and *Scedosporium*-like fungi. For example, *S. apiospermum* (Sacc.) Castellani and Chalmers (Fig. 8), the anamorph of *Pseudallescheria boydii* (Shear) McGinnis, Padhye, and Ajello, is probably the best known and perhaps the only other "good" species in the genus. *Scedosporium sclerotiale* (Pepere) Castellani and Chalmers was treated as a synonym of *S. apiospermum* by Brumpt (1922) and apparently by Pepere himself, while Borelli (1963) transferred it to the genus *Hyalopus* (*Acremonium*). Arx

(1973) discussed several *Pseudallescheria (Petriellidium)* species which have *Scedosporium*-like anamorphs. However, none of these species form basally swollen conidiogenous cells nor grow as slowly on Leonian's medium as *S. inflatum*.

The isolation of *S. inflatum* from the bone biopsy to the exclusion of all other fungi and the observation of fungal hyphae, morphologically consistent with the organism, in methenamine-silver stained biopsy sections clearly suggest that it was the etiologic agent of the boy's osteomyelitis. In addition, the hyphal fragments in the sections showed positive fluorescence when stained with a fluorescein-tagged antibody to *S. apiospermum*. Such cross-reaction between members of the same genus would not be unexpected.

A complete discussion of the case history involving this new species is in preparation.

The taxonomic link between *Scedosporium* and *Scopulariopsis* has not gone unnoticed. Both genera contain darkly pigmented (dematiaceous) species, and both are characterized by percurrently proliferating, holoblastic conidiogenous cells (annellides). In addition, both genera are applied to anamorphs of Microascaceae (Arx, 1973; Malloch, 1970).

Campbell and Smith (1982), in an excellent account of conidiogenesis in *S. apiospermum*, compared its conidiogenous cells with those of *Scopulariopsis brevicaulis* (Fig. 7) and noted only slight morphologic differences, e.g., conspicuous external wall scars in *Scopulariopsis brevicaulis* as opposed to the annular swellings in *Scedosporium apiospermum*. The authors even suggested transferring *Scedosporium apiospermum* to *Scopulariopsis*, citing also the supposedly invalid publication of *Scedosporium*. However, McGinnis (1980) noted that Castellani and Chalmers (Castellani, 1919) had validated Saccardo's (1911) original, invalid publication of *Scedosporium*. The conidiogenous cells of *S. inflatum* are morphologically quite similar to those of *Scopulariopsis brumptii* (compare Figs. 1-3 with that of Fig. 6).

Three lines of evidence indicate that *Scedosporium* and *Scopulariopsis* are distinct taxa. (1) The coarse annellides of *Scedosporium* species, with their irregularly spaced annular thickenings, are quite dissimilar from the close, evenly spaced thickenings of the more regular annellides of *Scopulariopsis* species. The irregular annellides of *Scedosporium* appear to result from the formation of some conidia slightly to the side of the old scar, almost to the point of being sympodial rather than percurrent. (2) In *Scopulariopsis* conidia are formed in dry chains at the apices of the conidiogenous cells, whereas those of *Scedosporium* are formed in wet clumps. (3) *Scedosporium* is applied to anamorphs of *Pseudallescheria* and possibly *Petriella* species, while *Scopulariopsis* species are anamorphs of *Microascus*, *Kernia*, and (rarely) *Chaetomium*. Although this argument uses biologic evidence to support the taxonomy of purely anatomic (form) genera, it nonetheless cannot easily be ignored, even by the most strict adherents to the Code.

Carrying this "biological argument" one step further, *Scedosporium apiospermum* is more commonly associated with mammalian infections than *Scopulariopsis brevicaulis*. While inherently a weak pathogen, *Scedosporium apiospermum* has been reported as the etiologic agent of a broad spectrum of clinical diseases. It is commonly associated with mycetomas (Rippon, 1982), i.e., cutaneous and subcutaneous infections of the extremities. It has also been involved in upper respiratory or lung infections and, as an opportunistic pathogen, with mycotic keratitis, meningitis, endocarditis, disseminated systemic disease, and other clinical conditions. In contrast, *Scopulariopsis brevicaulis* has been only infrequently associated with mammalian infections, usually in severely debilitated individuals.

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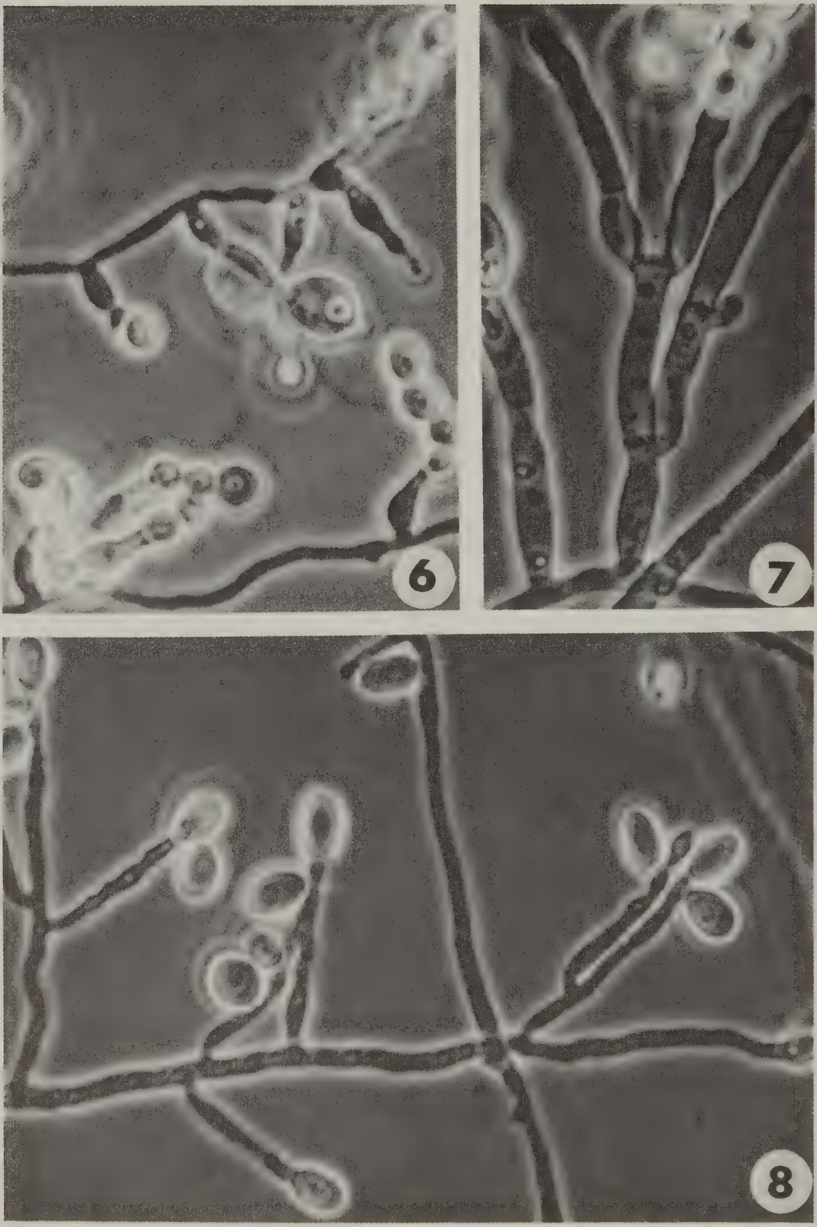

Fig. 6-8. Fig. 6. *Scopulariopsis brumptii*, Rood #13 (TRTC). Fig. 7. *S. brevicaulis*, Kaye #4 (TRTC). Fig. 8. *Scedosporium apiospermum*, Babcock #13 (TRTC). (All figures X 1500).

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ERYNIOPSIS, A NEW GENUS OF THE ENTOMOPHTHORACEAE (ENTOMOPHTHORALES)

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Eryniopsis Humber, a new genus of the Entomophthoraceae (Zygomycetes: Entomophthorales) is described for species whose primary conidia are plurinucleate (ca. 4-12 nuclei), unitunicate, and elongate (rather than globose to pyriform), produced on simple to dichotomously or monopodially branched conidiophores, and forcibly discharged by papillar eversion. Secondary capilliconidia, when present, are attached orthotropically (in axial alignment with the capillary conidiophore) rather than heterotropically as in Erynia species. In addition to the type species, Eryniopsis lampyridarum (Thax.) Humber, the genus includes Eryniopsis caroliniana (Thax.) Humber and Eryniopsis longispora (Bałazy) Humber.

The principles establishing a phylogenetic classification for the Entomophthorales delimit genera by the various combinations of differing states for relatively few characters (Humber 1981, 1984; Ben-Ze'ev and Kenneth 1982a-b). One attractive feature of such an approach is that it readily indicates when a unique combination of significant character states should be described as a new genus.

As accepted by Humber and by Ben-Ze'ev and Kenneth, no described genus of the Entomophthorales could correctly include entomopathogenic species whose conidiophores are mostly simple and bear plurinucleate, unitunicate conidia that are elongate rather than globose to pyriform. Each of the three species noted below to have this combination of characters has relatively large nuclei whose heterochromatic contents stain readily with aceto-orcein, bismarck brown, and other stains of chromatin (Figs. 3-6). These species belong, therefore, in the Entomophthoraceae rather than the Ancylistaceae (including genera with small nuclei, prominent nucleoli, and lacking readily stainable interphasic heterochromatin; see Humber 1981, 1984).

Humber (1981) and Ben-Ze'ev and Kenneth (1982a-b) rejected the use of conidial morphology as a generic character of overriding significance (cf. Remaudière and Keller 1980). However, conidial morphology does indicate to which of two lineages of entomopathogenic genera a species in the Entomophthoraceae might belong (Humber 1983a). The presence of elongate-ovoid to fusoid and curved conidia on conidiophores with limited apical branching clearly suggests a closer affinity of these species with *Erynia* sensu Humber & Ben-Ze'ev (1981) and *Strongwellsea* than with *Entomophaga* Batko, *Neozygites* Witlaczil (= *Triplosporium* (Thax.) Batko), *Entomophthora* Fres., or *Massospora* Peck.

ERYNIOPSIS Humber, gen. nov.

NUCLEI *comparate magni, nucleoplasmate semper filamentis vel granulis heterochromis et prompte per "aceto-orcein" vel "bismarck brown" coloratis repleto, sine nucleolo centrali prominenti; saepe in hyphis uniseriatim ordinati.* ***CONIDIOPHORA*** *simplicia vel sparse monopodialiter vel dichotome ramosa; quoque ramo conidium singulum apicale formante.* ***CONIDIA PRIMARIA*** *unitunicata, plurinucleata (nucleis saepissime 4-12); elongata, ovoideocylindrica vel fusiformia; recta vel arcuate curvata; vehementer eversione papillae basalis plus minusve distinctae expulsa.* ***CONIDIA SECUNDARIA*** *vel elongata vel conidia primaria simulantia vel in speciebus nonnullis ut capilliconidia elongata formata, sine haptero apicali, parietibus exilibus, ad conidiophorum capilliforme orthotropice affixa.* ***SPORAE PERDURANTES*** *globosae; exosporio hyalino; lateraliter vel terminaliter ex cellulis parentalibus pullulantes.* ***RHIZOIDEA*** *absentia, sive numerosa et ab hyphis vegetativis aegre differentia, sine haptero disciformi terminali.* ***CYSTIDIA*** *desunt. Species entomopathogenae.*

NUCLEI relatively large, with nucleoplasm containing obvious heterochromatin at all times, without a prominent central nucleolus; staining readily with aceto-orcein or bismarck brown, often in uniseriate arrangement in hyphal bodies or hyphae. **CONIDIOPHORES** mostly simple or monopodially to dichotomously (but not digitately) branching; each branch producing a single, apical conidium. **PRIMARY CONIDIA** unitunicate; plurinucleate (usually with 4-12 nuclei); elongate, ovoid-cylindrical to fusoid; straight or curved; with a more or less distinct basal papilla; forcibly discharged by papillar eversion. **SECONDARY CONIDIA** either resembling primary conidia or elongate, forcibly discharged; **CAPILLICONIDIA** formed in some species, thin-walled, without an apical adhesive organ (haptor), and attached orthotropically (with axes of spore and capillilary conidiophore aligned). **RESTING SPORES** budded laterally from gametangia or parental hypha; globose; with hyaline exospore. **RHIZOIDS** absent or, when present, numerous, relatively undifferentiated from vegetative hyphae, not terminating in a disc-like holdfast. **CYSTIDIA** not known to be present. Occurring as obligate entomopathogens.

TYPE SPECIES:
Eryniopsis lampyridarum **(Thaxter) Humber**, comb. nov.
Basionym: *Empusa (Entomophthora) lampyridarum* Thaxter, 1888, Mem. Boston Soc. Nat. Hist. 4: 169.
LECTOTYPE: FH 4641
Entomophthora lampyridarum (Thaxter) MacLeod & Müller-Kögler, 1973, Mycologia 65: 858.
ADDITIONAL SPECIES:
Eryniopsis caroliniana **(Thaxter) Humber**, comb. nov.
Basionym: *Empusa caroliniana* Thaxter, 1888, Mem. Boston Soc. Nat. Hist. 4: 167.
LECTOTYPE: FH 4670
Entomophthora caroliniana (Thaxter) Keller, 1978, Sydowia Ann. Mycol. 31: 88.
Erynia caroliniana (Thaxter) Remaudière & Hennebert, 1980, Mycotaxon 11: 302.
Eryniopsis longispora **(Bałazy) Humber, comb. nov.**
Basionym: *Entomophthora longispora* Bałazy, 1982, Bull. Acad. Pol. Sci., Sér. Sci. Biol. 29: 222.
TYPE: Bałazy 1266a, deposited at the Department of Agricultural and Forest Biology, Polish Academy of Sciences, Poznan

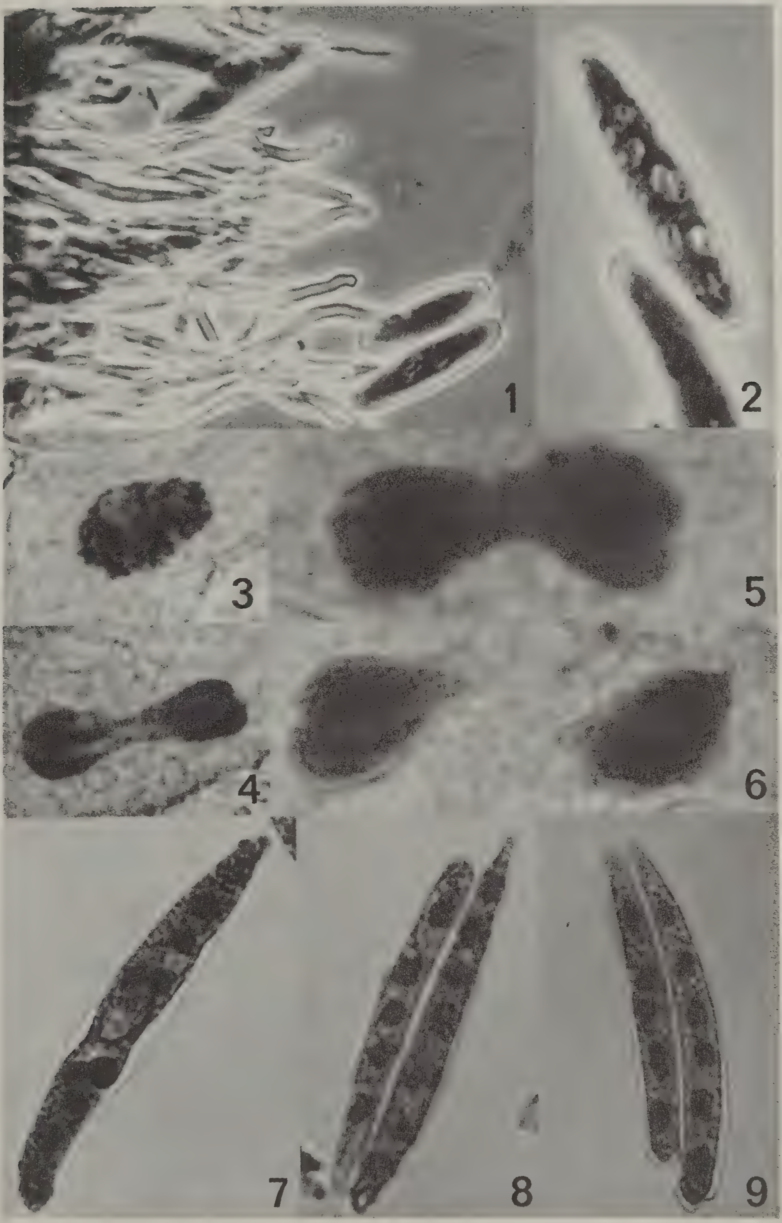
The resemblance of the species of this new genus with those of *Erynia* is suggested in the choice of the name *Eryniopsis*. The only other genus with which species of *Eryniopsis* might be confused is *Macrobiotophthora* Reukauf emend. Tucker (1981) but the primary conidia of the latter genus are not so cylindric-elongate as in *Eryniopsis* species. It also appears to be significant that *Eryniopsis* species are obligately entomopathogenic while those of *Macrobiotophthora* are pathogens of terricolous invertebrates outside of the Arthropoda. This fundamental division of entomophthoralean genera by virtue of the habit — terricolous (saprobic or pathogenic for plants or soil invertebrates with a few entomopathogens) or wholly and obligately entomopathogenic is discussed by Humber (1982b).

It is hardly surprising that *Empusa lampyridarum* Thax. has been a troublesome species in recent attempts to clarify the systematics of the Entomophthorales. Until the recent rediscovery of this species by Carner (1980), all extant information about the fungus was limited to the fragmentary description offered by Thaxter (1888). Thaxter probably placed this species in *Empusa* subg. *Entomophthora* by virtue of its secondary capilliconidia like those in other species now classified in *Erynia* subg. *Zoophthora* (Batko) Ben-Ze'ev & Kenneth (1982b) and his assumption that the conidiophores were digitately branched. Batko apparently declined to assign this species to any of his genera since the number of conidial nuclei was not mentioned by Thaxter (1888). The primary conidial morphology of *E. lampyridarum* corresponds to that in *Erynia* or (less well) *Zoophthora* in Remaudière and Hennebert's (1980) sense of these genera, but is mentioned by neither Remaudière and Hennebert (1980) nor Remaudière and Keller (1980).

Thaxter's material of *Empusa lampyridarum* (FH 4641, type, Cullowhee, North Carolina; FH 4676 from Fayetteville, Arkansas, Oct. 1888; FH 6413, from Kansas, 1888?; and FH 6412, from Fayetteville, Arkansas; the latter three collections were by C.W. Woodworth and identified by R. Thaxter), all from *Chauliognathus pennsylvanicus*, contain abundant capilliconidia which were found to be unitunicate and mostly 4-6 nucleate (Fig. 1-2). The cytoplasmic bodies illustrated in the conidia of this species by Thaxter (1888; plate 17, figs. 161-171) must have been the nuclei; these structures appear as negatively stained bodies in Figs. 1 and 2. The conidiophores in these herbarium specimens are unusually difficult to separate, even after prolonged softening in lactophenol; however no evidence was found to support Thaxter's uncertain supposition that the conidiopores of this species are digitately branched.

Empusa caroliniana Thaxter was placed in *Erynia* Nowakowski by Remaudière and Hennebert (1980) solely because its primary conidia are elongate and cylindrical despite the inclusion of several nuclei and presence of a unitunicate rather than bitunicate conidial wall. In a predictive, phylogenetic classification, however, *Erynia* must be limited to species producing uninucleate, bitunicate conidia

Figs. 1-2. *Eryniopsis lampyridarum*. 1. Capillary conidiophores and capilliconidia (lactophenol/aniline blue), 575x. 2. Capilliconidia showing several large nuclei (lactophenol/aniline blue), 1150x. Figs. 3-6. *Eryniopsis caroliniana*. (IPRU strain RS-640; isolated from *Tipula paludosa* by S. Keller) 3. Interphase nucleus; aceto-orcein, 1300x. 4-5. Anaphase showing long, vermiform chromosomes (from culture); aceto-orcein, 1300x and 2300x. Fig. 6. Anaphase (nuclei



still drawing apart although already separated); aceto-orcein, 2300x. Fig. 7-9. *Eryniopsis longispora*. Multinucleate primary conidia; aceto-orcein, 800x.

on conidiophores that are almost always dichotomously or digitately branched (Humber 1981, 1982a-b; Humber and Ben-Ze'ev 1981; Ben-Ze'ev and Kenneth 1982a-b). Even though primary (but not secondary) conidia are regarded to have taxonomic significance at the generic level, the presence of a fusoid type of forcibly discharged secondary conidium in *Eryniopsis caroliniana* (Keller 1978) and in the undescribed species mentioned below again supports the supposed relationship of this genus with *Erynia* sensu Humber & Ben-Ze'ev.

Eryniopsis longispora is a fungus affecting tendipedid gnats (Bałazy 1978, 1982; Humber 1981) with 4-10 nuclei in slender, curved, unitunicate conidia with a flared shoulder immediately above the obtusely conical papilla (Figs. 7-9). A small proportion of the conidiophores of this species are monopodially or dichotomously branched (Fig. 10); this degree of conidiophore branching is a clear intermediate between the unbranched conidiophores characteristic of nearly all entomophthoralean genera and the richly branched conidiophores found only in *Erynia* species. Bałazy (1978) originally regarded this gnat fungus to be a new species of *Culicicola* Nieuwland sensu Batko, a genus which has been rejected as a mixture of species of *Entomophthora* Fres. (s. str.) and *Conidiobolus* Bref. (or *Entomophaga* Batko) (Remaudiere and Keller 1980; Humber 1981). Bałazy (1982) subsequently described it as a species of *Entomophthora* sensu stricto; however, this particular generic assignment is unacceptable in the recent generic classifications which restrict that genus to species with campanulate/apiculate conidia and a cannon-like mechanism for conidial discharge (Remaudière & Keller 1981; Humber 1981; Ben-Ze'ev & Kenneth 1982a).

As noted by Humber (1981), the generic assignment of *E. longispora* substantially tests the premises used to construct a generic classification for the Entomophthorales. The conidial and rhizoidal morphologies and general habit of *Eryniopsis longispora* are nearly identical to those of *Erynia conica* (Now.) Rem. & Henneb.. However, the presence of multiple nuclei in unitunicate conidia in the former species, however, excludes it from any of the four subgenera of *Erynia* (Ben-Ze'ev & Kenneth 1982b; Li & Humber 1984): The presence or absence of capilliconidia has been rejected as a character of generic significance (Humber 1981; Ben-Ze'ev and Kenneth 1982a); flared papillar shoulders are present on conidia of species in both *Erynia (Erynia)* and *Erynia (Zoophthora)*; similarly, elongate and curved (bilaterally symmetrical) conidia are produced by species of these same two *Erynia* subgenera. Strong evidence presented by Humber (1981, 1982; Humber & Ben-Ze'ev 1981) and Ben-Ze'ev and Kenneth (1982a-b) argues against the systematic soundness of accepting *Erynia* and *Zoophthora* as separate genera

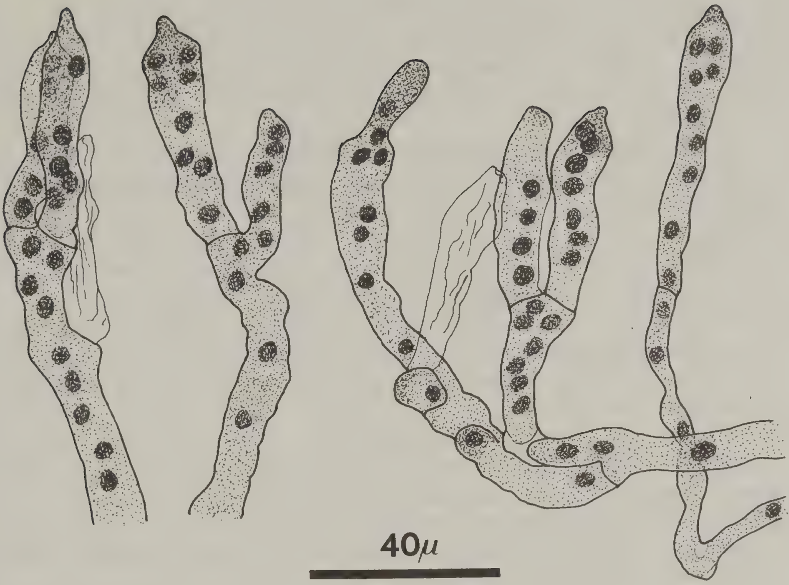


Fig. 10. *Eryniopsis longispora.* Conidiophores from tendipedid gnats; redrawn from Bałazy's camera lucida sketches.

(Remaudière and Hennebert 1980; Remaudière and Keller 1980). There is general agreement, however, among all proponents of these two taxonomic viewpoints to segregate those *Erynia*- or *Zoophthora*-like species with unitunicate plurinucleate conidia in a new genus.

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THE IDENTITY OF ENTOMOPHAGA SPECIES (ENTOMOPHTHORALES: ENTOMOPHTHORACEAE) ATTACKING LEPIDOPTERA

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Entomophaga aulicae (Reichardt) Humber, comb. nov. (Entomophthorales: Entomophthoraceae), is retained as distinct from Entomophaga grylli (Fres.) Batko; the known host ranges for E.aga aulicae and E.aga grylli are restricted to the Lepidoptera and Orthoptera, respectively. An invalidly described Entomophthora species originally distinguished from other entomophthoralean species principally by its formation of amoeboid protoplasts in liquid culture media is identical to E.aga aulicae in all other respects, and is regarded as a synonym of E.aga aulicae. A morphologically similar fungus from tabanid flies is transferred to this genus as Entomophaga tabanivora (Anderson & Magnarelli) Humber, comb. nov.. Protoplastic vegetative forms are now known to occur naturally in several genera of the Entomophthorales: Entomophthora, Massospora, Entomophaga, Strongwellsea, Erynia, and possibly Neozygites.

Empusa aulicae Reichardt in Bail (1869), from lepidopteran hosts, has always been confused with *Entomophthora grylli* Fresenius (1856, 1858), which was described from crickets, but is best known from a wide variety of grasshoppers. Both species have pyriform primary conidia and resting spores which are nearly identical in both size and appearance. Other major taxonomic features are identical: the unbranched conidiophores, lack of both rhizoids and cystidia, forcibly discharged pyriform to subglobose secondary conidia, and lack of secondary capilliconidia. Several influential workers have regarded *Empusa aulicae* to be a synonym of *E.ora grylli* (Thaxter

1888; Batko 1964a-b; Gustafsson 1965; Remaudiere & Keller 1980). Nowakowski (1883) discussed a mosquito pathogen which he believed to be *E.ora grylli*; this fungus was most probably a misidentification of *Entomophthora conglomerata* Sorokin.

The early taxonomic history of *Entomophthora aulicae* (Reich.) Sorokin and rationale for retaining this species as distinct from *E.ora grylli* are summarized by MacLeod and Muller-Kogler (1973). The generic placement of *Entomophthora aulicae* has remained unresolved since the beginning of the trend to abandon *Entomophthora* sensu lato in favor of a system of more narrowly defined genera. In these later classifications, *Entomophthora aulicae* belongs in either *Conidiobolus* Bref. in the morphologically based classification of Remaudiere & Keller (1980) or in *Entomophaga* Batko in the phylogenetically based classifications of Humber (1981) and Ben-Ze'ev and Kenneth (1982).

Thaxter (1888) provides the only report of apparently successful cross-infection of the grasshopper fungus to lepidopterans. He exposed caterpillars of two arctiid species, *Spilosoma virginica* and *Hyphantria textor*, collected at Kittery Point (Maine) during the summer of 1886 to conidia showered from diseased grasshoppers collected from a nearby site. Within 8 days, all *S. virginica* larvae had died and displayed infections of a fungus like that from the grasshoppers (although no uninoculated caterpillars were checked for disease development). None of the *Hyphantria* larvae were affected by the fungus. Thaxter (1888) and Lakon (1919) were unable to transmit the lepidopteran fungus to grasshoppers.

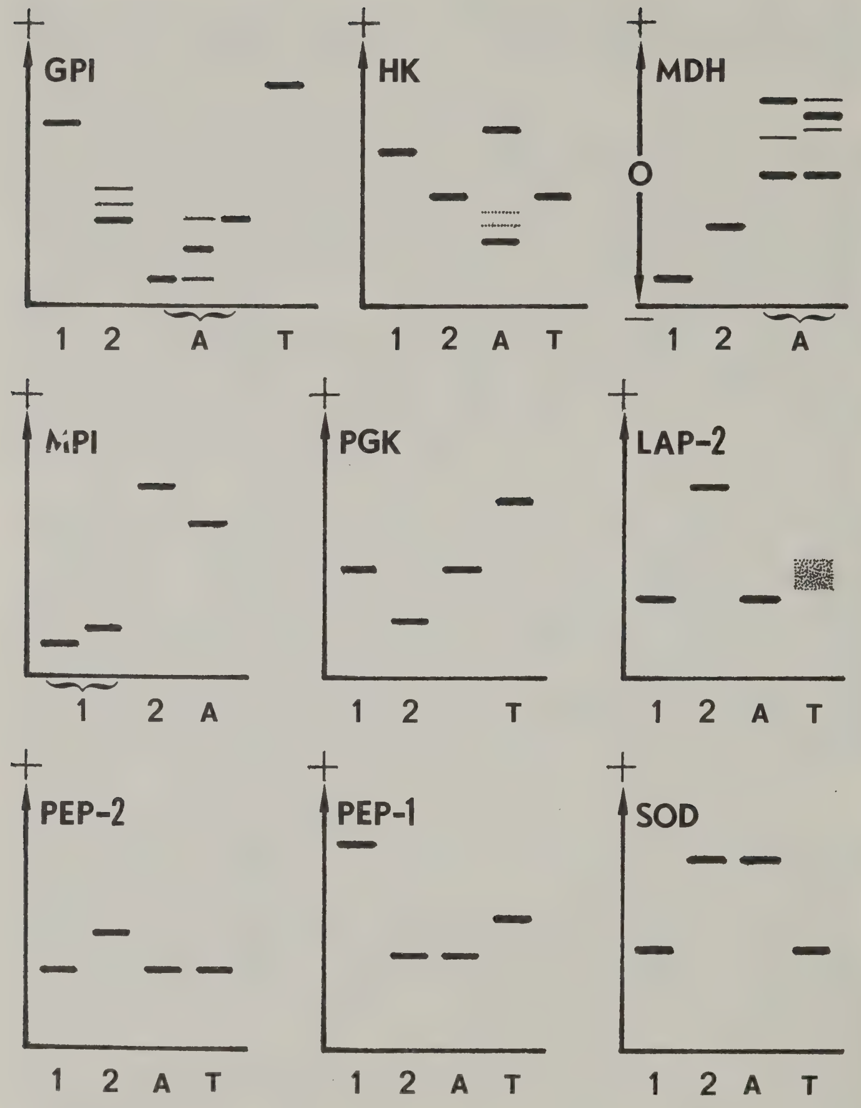
While it is possible to offer diverse arguments supporting the separation of *E.aga grylli* and *E.ora aulicae*, no evidence can be so entirely persuasive as that offered by reproducible biochemical differences. The analysis of isoenzymes by starch-gel electrophoresis (May et al 1979; Soper et al. 1983; Milner et al. 1983) is becoming an invaluable tool for research in the systematics of the Entomophthorales.

The distinct electrophoretic banding patterns on starch gels have proven so far to be species specific, with little or (surprisingly often) no variation seen in groups of cultures of a particular species coming from diverse sites and hosts. The distinctive set of banding patterns obtained when using several key enzyme systems can be used to "define" individual species. One example where these techniques have been used to obtain unambiguous differentiations of morphologically similar species is in the clarification of a species complex which includes *Erynia neoaphidis* Remaud. & Henneb., *Erynia delphacis* (Hori) Humber, *Erynia nouryi* Remaud. & Henneb., and *Erynia kondoiensis* Milner & al., a new species from *Acyrthosiphon kondoi* (Milner et al. 1983; Humber and B. May, unpublished).

Electrophoretic studies were undertaken with several enzyme systems from numerous isolates of the two biologically and biochemically distinct pathotypes of *Entomophaga grylli* from North American grasshoppers (Soper et al. 1983) and of 5 strains of *Entomophthora aulicae* (RS-51, RS-167, RS-168, and RS-172 from *Choristoneura fumiferana* in Maine, and RS-251 from *Heliothis* sp. in Georgia; Humber, unpublished) (Fig. 1). There is no notable variation of banding positions within groups of strains identifiable by their overall isozymatic banding patterns as either pathotype of *E.aga grylli*; these patterns were found to be independent of the host species or site from which the fungus was obtained or of the developmental stage of the fungus examined (Soper et al. 1983). While the strains of *E.ora aulicae* shared some banding positions with either of the two *E.aga grylli* pathotypes, the composite banding pattern for all isozymes of these strains differed significantly from those of *E.aga grylli.* The banding patterns for *Entomophthora tabanivora* (RS-627) isolated from a tabanid fly, *Atylotus thoracicus*, near McLean, New York, (Mullens et al. 1983) are included for comparative purposes. The banding patterns for isozymes of *E.ora aulicae*, *E.ora tabanivora*, and the pathotypes of *E.aga grylli* are consistent and reproducible differences; the differences between the banding patterns of these fungi reflect taxonomic differences rather than artefacts of the techniques used.

A second entomophthoraceous fungus from lepidopterans, whose development and physiology has been studied extensively by Dunphy and Nolan (1977a-b, 1979, 1980, 1981a-b, 1982a-b) has opened wholly new areas for studies in entomophthoralean biology. This was the first entomophthoralean fungus reported to produce amoeboid protoplasts in tissue culture medium (Tyrrell and MacLeod 1972). In a footnote, Otvos et al. (1973) described the fungus as *Entomophthora egressa* MacLeod & Tyrrell, to be "distinguished from related *Entomophthora* species by the spontaneous release of protoplasts in Grace's tissue culture medium (protoplastus in medio culturae Gracii suo motu liberatus)". All other characters in the protologue are identical with those of *E.ora aulicae.* *Entomophthora egressa* was invalidly published, however, since the designated type (No. 458, Insect Pathology Research Institute, Sault Ste. Marie, Ontario) is a living culture rather than a dried specimen of an infected insect or microscope slide in accordance with the International Code of Botanical Nomenclature.

The key character distinguishing this protoplastic fungus from other entomophthoraleans lost all significance with the discovery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LAP-2
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PEP-2
1 2 A T
+
PEP-1
1 2 A T
+
SOD
1 2 A T

Fig. 1 Starch gel zymograms of *Entomophaga grylli*, pathotype I (1; IPRU strains RS-499, RS-618, RS-619, RS-620, RS-623, RS-625, RS-629) and pathotype II (2; RS-408, RS-646), *Entomophaga aulicae* (A; strains RS-51, RS-167, RS-168, RS-172, RS-251), and *Entomophaga tabanivora* (T; strain RS-627). Enzymes examined: GPI = glucose-phosphate isomerase; PGK = phospho-glycerate kinase; SOD = super-oxide dismutase; isomerase; HK = hexokinase; LAP-2 =

that amoeboid protoplasts occur naturally not only in this species (Tyrrell 1977) but in many other entomophthoraleans. Fusoid amoeboid protoplasts are now known to occur naturally in *Entomophaga grylli* (MacLeod et al. 1980; Soper et al. 1983), *Massospora cicadina* (R. S. Soper, unpublished), *Entomophthora muscae* (R. A. Humber, unpublished), and hypha-like protoplasts from *Erynia neoaphidis* and *Entomophthora planchoniana* (Butt et al. 1982; Holdom 1983), *Erynia radicans* (R. A. Milner and R. S. Soper, unpublished), and *Strongwellsea magna* (Humber 1975). In most instances, these protoplasts can be maintained in liquid culture media.

Species cannot be appropriately differentiated by their ability or inability to release amoeboid protoplasts in a specific culture medium. Some strains of *Entomophaga grylli* which produced protoplasts in their natural hosts are difficult to establish or to propagate in culture as protoplasts. These strains tend to die or to be lost through formation of thick-walled prespores. A few cells produce very sparse hyphal growth (reminiscent of germ tube formation) which cannot be successfully proliferated; cultures containing these hyphae occasionally release a few rather feeble protoplasts.

Naturally occurring protoplastic vegetative states may be transitory in some species, or undergo morphological changes which mask their protoplastic nature. For example, amoeboid, fusoid protoplasts are found in the blood of flies infected by a fungus of the *Entomophthora muscae* complex during the first 24 hours after infection. After this initial phase, rod-like hyphal bodies are the normal vegetative form of this fungus until just before sporulation (Brobyn and Wilding 1983); these rod-like hyphal bodies are also wall-less protoplasts (Humber, unpublished).

In summary, all biological evidence suggests that *Entomophthora aulicae* and *Entomophthora grylli* are separate species. Further, *Entomophthora egressa* must be regarded as an invalidly published synonym of *E.ora aulicae*. The remaining question, then, is to which genus these species must be assigned.

Batko (1964b; Batko and Weiser 1965) failed to find strong differences between *Entomophaga* and *Conidiobolus*. Remaudière

leucine aminopeptidase; MDH = malate dehydrogenase; PEP-2 = peptidase with leucyl-leucyl-leucine; PEP-1 = peptidase with leucyl-leucyl-leucine; MPI = mannosephosphate isomerase. Procedures for growth *in vitro* and starch-gel electrophoresis are given in Soper et al. (1983).

and Keller (1980) synonymized *Entomophaga* with *Conidiobolus* because all species in both these genera produce pyriform to globose, unitunicate, papillate, multinucleate conidia on simple conidiophores. However, substantial cytological and developmental evidence suggests that *Entomophaga* and *Conidiobolus* must be recognized as separate genera in different families, the Entomophthoraceae and Ancylistaceae, respectively (Humber 1981, 1984). Since the type species of *Entomophaga* is *E.aga grylli* (Fres.) Batko (1964a), it is obligatory that *Entomophthora aulicae* also be in that genus:

***Entomophaga aulicae* (Reichardt in Bail) Humber, comb. nov.**

≡ *Empusa aulicae* Reichardt in Bail, 1869, Schrift. Naturf. Ges. Danzig, n.s. 2(2): 3.

≡ *Entomophthora aulicae* (Reich.) Sorokin, 1876, Hedwigia 15: 148.

= *Empusa elegans* Majmone, 1914, Centralbl. Bakteriol., 2. Abt., 40: 107.

= *Entomophthora anticae* Reich. in Mitchell, 1919, Entomol. News 30: 193.

= *Entomophthora egressa* MacLeod & Tyrrell in Otvos, MacLeod, & Tyrrell, 1973, Canad. Entomol. 105: 1436. INVALID WITHOUT PROPER TYPIFICATION.

It is clear that the morphology, nuclear cytology, and developmental patterns of *Entomophthora tabanivora* indicate this species to be congeneric with the other species studied here:

***Entomophaga tabanivora* (Anderson & Magnarelli) Humber, comb. nov.**

≡ *Entomophthora tabanivora* Anderson & Magnarelli, 1979, J. Invertebr. Pathol. 34: 263.

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LICHEN COMMUNITY STRUCTURE IN BETATAKIN CANYON, NAVAJO NATIONAL MONUMENT, ARIZONA

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SUMMARY

The saxicolous and corticolous lichen communities in Navajo National Monument have been under study for the past five years. Several community analyses were performed on our quantitative data. The results of our cluster analyses demonstrated that distinctive lichen communities exist on separate bark and rock substrates. Furthermore, these communities are not closely related to each other with an average similarity of only 4.2%. Community diversity was low on most substrates except *Pseudotsuga menziesii* and Navajo Sandstone cliff faces.

INTRODUCTION

Little work has been done to characterize lichen community structure in arid parts of western North America. However, recently Nash (1974), Marsh and Nash (1979) and Rushforth et al. (1982) have examined lichen communities in the southwestern United States. This work provides important baseline information on the lichens of this area prior to proposed large scale energy development. This is especially important since some species of lichens have been shown to be sensitive to air pollution (Hawksworth and Rose 1976, Skye 1979, Will-Wolf 1980a, 1980b).

An investigation of lichen community structure on all major corticolous and saxicolous substrates in Betatakin Canyon, Navajo National Monument, Arizona and the surrounding slickrock areas above the canyon was performed during the summers of 1980 and 1981. Voucher specimens of all species are deposited in the lichen herbarium at Brigham Young University, Provo, Utah.

Our objectives for this study were to identify all lichen species present in this area, to determine relative abundance of these species and to characterize lichen community structure on various substrate types. This information will serve as a baseline for evaluating the effects of future energy related development and processing on lichen communities in Navajo National Monument.

STUDY AREA

Navajo National Monument is located is northeastern Arizona and is the site of three large Anasazi Indian cliff dwellings. Betatakin Canyon, the site of the present study, is a side canyon of the larger Tsegi Canyon complex described by Hack (1945). The major geological formation within the canyon is Navajo Sandstone, which forms sheer towering cliffs 200 m or more in height. The canyon floor consists of deep alluvial deposits of sandy Quarternary fill. Kayenta sandstone outcrops in the lower reaches of the canyon.

The annual temperature recorded at park headquarters at Betatakin canyon ranges from -23°C to 38°C with a mean of 10°C. The number of frost-free days in the area varies from 107 to 213, with an average of 155 days. Total annual precipitation ranges from 17 cm to 48 cm with a yearly mean of 29 cm. There is a single wet season, lasting from late summer to fall.

Corticolous and saxicolous lichen communities were studied in two major areas of the Monument. Slickrock and pinyon-juniper habitats were sampled in the area surrounding the Monument headquarters above Betatakin Canyon. The bark of *Populus tremuloides*, *Pseudotsuga menziesii*, *Quercus gambelii*, as well as Navajo Sandstone cliff faces were examined in the bottom of the canyon.

DATA COLLECTION

Transects were established subjectively at all study sites in areas with sufficient density of trees or cliff faces to insure adequate study of lichen communities. Individual trees for determining the occurrence and distribution of corticolous lichens were selected using the quarter method (Phillips 1959). This method is a proven plotless sampling technique in which points along a line transect are identified. The area around each point was divided into four quadrants and the nearest tree in each quadrant was sampled. Vertical cliffs at each of the study sites were selected on the basis of size and exposure.

Frequency and estimated percent cover of both saxicolous and corticolous lichens were determined using 2 x 100 cm quadrats with 10 equal subquadrats. These quadrats were placed at measured intervals along established transect lines for saxicolous species and on each side of tree stems for corticolous species. Table 1 lists the total number of quadrats studied for each substrate type.

DATA ANALYSIS

Several statistical analyses were performed on the data collected. Stand similarity indices were calculated following the methods of Ruzicka (1958). Cluster analysis was then performed by comparing each stand to all other stands using arithmetic averages (Sneath and Sokal 1973). This method has been used extensively in ecological studies because it introduces less distortion than other methods (Kaesler and Cairns 1972).

Species diversity was determined in two ways. First, the total number of species encountered on each substrate type (species richness) was calculated. Second, Shannon-Wiener diversity indices for each substrate type were also calculated (Shannon and Wiener 1949, and Patten 1962). We chose this index since it takes into account both species richness and evenness of abundance of each taxon, in each sample.

An importance value for each species for the overall study was calculated by multiplying average frequency by average cover (Warner and Harper 1972).

Niche breadths and niche overlaps for all lichen species were calculated following Colwell and Futuyma (1971). Cluster analysis on the basis of niche overlap was also performed (Jatkar *et al*. 1979).

RESULTS AND DISCUSSION

The results of our cluster analysis of all stand types showed a very low similarity between substrate types demonstrating that all substrates examined were relatively distinct from one another. *J. osteosperma* and *Q. gambelii* were most closely related with 33% similarity. Slickrock and cliff face communities were 15% similar. Similarity between all other substrate types was less than 10%.

Table 1. Listing of the number of transects studied and the number of lichen species encountered by substrate type. Shannon-Wiener diversity indices are also recorded for each substrate type.

Substrate Type	Number of Transects Studied	Number of Species Encountered	Diversity Index
Juniperus osteosperma	212	3	1.5000
Pinus edulis	92	4	1.1771
Populus tremuloides	72	6	1.6794
Pseudotsuga menziesii	128	19	3.8043
Quercus gambelii	96	2	0.8113
Navajo sandstone cliff face	42	32	3.5377
Navajo sandstone slickrock	16	9	1.7207

Table 2. Lichen species in Navajo National Monument with importance values 0.01 or greater. These taxa are listed with their importance values and relative niche breadths. Importance values were calculated by multiplying percent presence by average percent cover. Niche breadths were calculated after Colwell and Futuyma (1971).

SPECIES	IMPORTANCE VALUE	NICHE BREADTH
ALL SUBSTRATE TYPES COMBINED		
Aspicilia calcarea	1.21	0.343
Lecidea tessellata	0.30	0.417
Staurothele clopima	0.20	0.663
Candelariella rosulans	0.12	0.496
Lecanora frustulosa	0.09	0.516
Acarospora fuscata	0.05	0.386
Parmelia lineola	0.04	0.404
Lecanora muralis	0.02	0.386

SPECIES	IMPORTANCE VALUE	NICHE BREADTH
Diploschistes actinostomus	0.02	0.410
Aspicilia caesiocinerea	0.02	0.343
Physcia endococcinea	0.01	0.386
Caloplaca fraudans	0.01	0.459
Collema polycarpon	0.01	0.699
Candelariella vitellina	0.01	0.386
Caloplaca arizonica	0.01	0.137
Parmelia substygia	0.01	0.126
BARK SUBSTRATES		
Caloplaca arizonica	0.01	0.137
Xanthoria species	0.01	0.138
Candelariella deflexa	0.01	0.496
Parmelia subolivacea	0.01	0.404
ROCK SUBSTRATES		
Aspicilia calcarea	14.86	0.343
Lecidea tessellata	3.63	0.417
Staurothele clopima	2.41	0.663
Lecanora frustulosa	1.14	0.516
Candelariella rosulans	0.67	0.496
Acarospora fuscata	0.57	0.386
Lecanora muralis	0.30	0.386
Aspicilia caesiocinerea	0.26	0.343
Parmelia lineola	0.17	0.404
Physcia endococcinea	0.16	0.386
Caloplaca fraudans	0.14	0.459
Diploschistes actinostomus	0.13	0.410
Collema polycarpon	0.12	0.699
Candelariella vitellina	0.09	0.386
Parmelia substygia	0.06	0.126
Lecanora novomexicana	0.03	0.386
Lecanora dispersa	0.02	0.386
Toninia caeruleonigricans	0.01	0.386
Caloplaca flavovirescens	0.01	0.386
Lecanora crenata	0.01	0.386
Acarospora strigata	0.01	0.386
Lepraria species	0.01	0.462

The substrate type with the greatest Shannon-Wiener species diversity was *Pseudotsuga menziesii* (3.804) followed closely by Navajo Sandstone cliff faces (3.538). However, total number of species was significantly higher on the cliff faces than on *P. menziesii*. Table 1 lists the total number of species encountered on each substrate together with a Shannon-Wiener diversity index for each substrate type.

Prevalent species determined by multiplying percent presence by average percent cover for all sites, regardless of substrate, were *Aspicilia calcarea* (importance value of 1.21), *Lecidea tessellata* (0.30), *Staurothele clopima* (0.20) *Candelariella rosulans* (0.12) and *Lecanora frustulosa* (0.09).

The dominant species on rock substrates (determined by the same method) were *Aspicilia calcarea* (14.86), *Lecidea tessellata* (3.63), *Staurothele clopima* (2.41), *Lecanora frustulosa* (1.14), *Candelariella rosulans* (0.67) and *Acarospora fuscata* (0.57).

The most important taxa on bark substrates were *Caloplaca arizonica* (0.01), *Xanthoria* species (0.01), *Candelariella deflexa* (0.01) and *Parmelia subolivacea* (0.01).

A listing of species encountered during this study according to broad substrate type together with their importance value is listed in Table 2.

Niche width and overlap measurements were performed in order to determine which species occupy similar habitats and which species are narrowly or broadly distributed. Table 2 presents the relative niche breadths of lichen species encountered. Lichens were then clustered on the basis of niche overlap. Several distinct species groups were evident from this analysis. The first was composed of species occurring exclusively on Navajo Sandstone cliff faces. Species included in this group were *Acarospora fuscata*, *Acarospora strigata*, *Aspicilia caesiocinerea*, *Buellia retrovertens*, *Caloplaca flavovirescens*, *Candelariella vitellina*, *Collema* species, *Lecanora badia*, *Lecanora crenata*, *Lecanora christoi*, *Lecanora dispersa*, *Lecanora muralis*, *Lecanora novomexicana*, *Parmelia substygia*, *Physica endococcinea*, *Rhizocarpon disporum* and *Toninia caeruleonigricans*.

A second group was composed of species which occurred on both sandstone cliff faces and horizontal slickrock exposures. Species included in this group were *Collema polycarpon*, *Staurothele clopima*, *Lecanora frustulosa*, *Aspicilia calcarea* and *Lecidia tessellata*.

A third group included species which were identified only from the bark of *Pseudotsuga menziesii*. Species in this group were *Buellia punctata*, *Buellia* species, *Heterodermia speciosa*, *Cladonia pyxidata*, *Lecidella euphorea*, *Lecidia* species, *Lecanora caesiorubella*, *Lecanora chlarotera*, *Parmelia subolivacea*, *Physcia dubia* and *Physconia grisea*.

The species *Parmelia lineola*, *Diploschistes actinostomus*, *Lepraria* species and *Candelariella deflexa* occurred on both rock and bark substrates. Most of these occurred at least on *Pseudotsuga* bark and cliff faces.

The last group was comprised of species occurring only on two or more separate bark substrates. Species in this group included *Caloplaca arizonica*, *Physconia pulverulenta*, *Xanthoria fallax*, *Lecanora hageni*, *Physcia stellaris*, *Usnea hirta* and *Xanthoria* species.

In comparing lichen distribution in Navajo National Monument and Zion National Park, several differences were observed. All substrates including Navajo sandstone, all tree and shrub species and the soil in Navajo National Monument supported substantially more species than was found on similar substrates in Zion National Park. For example, in Navajo National Monument 38, 22, and 14 lichen species were collected from sandstone, corticolous and terricolous substrates respectively while 26, 13, and 2 species were collected from those same substrates in Zion National Park. These differences can be explained, in part, on the basis of two factors: 1) some differences in vascular plant substrates, and 2) microclimatic differences in the two sites. The relative importance of these two factors are presently under investigation.

The lichens identified from Navajo National Monument were dominated by crustose species over fruticose and foliose species by more than two to one. This ratio is not surprising when comparisons to similar studies in desert environments are made (Marsh and Nash 1979, and Rushforth et al. 1982). Crustose lichens are uniquely adaptated for survival in harsh arid environments. Typically, the occurrence of fruticose and foliose species in dry environments is restricted to shaded, well protected areas where due to specific microclimatic features humidity is significantly higher.

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THE TYPIFICATION OF LECANORA SUBFUSCA (L.) ACH., ITS VARIETIES, AND SOME OF ITS RELATED TAXA PUBLISHED BEFORE 1850

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SUMMARY

Twenty-two early epithets used for species of crustose lichens in the *Lecanora subfusca* group are typified based on an examination of material mainly in the Acharian Herbarium in Helsinki. *Lichen subfuscus* L. will be proposed for rejection as a nom. ambig.; *L. argentata* (Ach.) Malme must replace *L. subfuscata* H. Magn.; and a new species (*L. circumborealis* Brodo & Vitikainen) is described to accomodate *L. coilocarpa* auct., non (Ach.) Nyl. Other pre-1850 names and their synonyms are listed and discussed.

In lichenology, the names of a few species, such as *Alectoria jubata* (L.) Ach. and *Usnea barbata* (L.) Wigg., stand out as having been used in such a broad, collective sense over such a long period of time that their original meaning has been thoroughly obscured. To these, we must surely add *Lecanora subfusca* (L.) Ach. Not only has this species been misunderstood, but its infraspecific allied taxa have similarly been used in varying and often contradictory senses for a very long time. In this paper, we hope to introduce some stability to the taxonomy of the *Lecanora subfusca* group by providing typifications for many of the oldest epithets, most of them representing widely distributed and frequently cited species.

We have been engaged in the study of the *L. subfusca* group for over 14 years, I.M.B. with the North American species and O.V. with the North European representatives. Although we decided to write a paper on the Acharian *subfusca* types in 1970, it has taken us until now to accumulate sufficient experience with the various taxa to enable us to feel comfortable with the decisions that had to be made.

Of the 22 epithets treated below, 17 are based on types in the Acharian herbarium in Helsinki (H-ACH). Other pertinent types and relevant specimens were seen in UPS or borrowed from K, OXF, G, LAU, PC or L. (Herbarium abbreviations are from Holmgren et al., 1981.)

TABLE 1. Summary of currently accepted names in the *L. subfusca* group treated in this paper.

Accepted names	Important synonyms mentioned in this paper
L. allophana Nyl.	*Lichen subfuscus* L., "nom. rej." prop.
L. argentata (Ach.) Malme	*L. subfuscata* H. Magn.
L. cateilea (Ach.) Mass.	
L. cenisia Ach.	*L. atrynea* (Ach.) Nyl.
L. circumborealis Brodo & Vitik.	*L. coilocarpa* auct., non (Ach.) Nyl.
L. epibryon (Ach.) Ach.	
L. farinaria Borrer ex Hooker	
L. campestris (Schaerer) Hue	*L. atra* var. *expansa* Ach.
L. gangalea Ach.	
L. glabrata (Ach.) Malme	*L. subfusca* var. *rufa* Ach.
L. horiza (Ach.) Lindsay	*L. parisiensis* Nyl.
L. miculata Ach.	
L. pulicaris (Pers.) Ach.	*L. chlarona* (Ach.) Nyl.; *L. coilocarpa* (Ach.) Nyl., non auct.; *L. pinastri* (Schaerer) H. Magn.
L. rugosella Zahlbr.	*L. rugosa* (Nyl.) Nyl., non *Lecanora rugosa* Ach.
L. rupicola (L.) Zahlbr.	*L. rugosa* Ach., non *Lichen rugosus* Pers. ex Ach., nom. inval.
L. zosterae (Ach.) Nyl.	*L. palanderi* Vain.

As we progressed with the study, we noted that a number of well-established names would have to be replaced with older names. We tried every possible means to avoid such name changes and, in several cases, succeeded in preserving traditional meanings. The remaining changes are regrettable, but necessary. A summary of the correct names together with the more important synonyms presented in this paper are given in Table 1.

We have listed and discussed the epithets below in their alphabetical order, regardless of their original or subsequent combinations. Full synonymy is not always given since this will form part of a more complete revision now in press (Brodo, 1984). Full typifications are made for most names, however, and descriptions or discussions of the types are given when appropriate and necessary. Chemical information is provided for some types based on our own investigations using thin-layer chromatography (TLC).

1. *Lecanora subfusca* [var.] η. *L.* *allophana* Ach., Lich. Univ. 395. 1810, nom. illeg. (Art. 63). Type: not assigned (see discussion below).

The species commonly known as "*L. allophana* (Ach.) Nyl." has often been regarded as one of the best defined in this group and without taxonomic problems. It has been overlooked, however, that its supposed basionym, cited above, is a superfluous name because three earlier varieties were cited in synonymy: *Parmelia subfusca* var. *flexuosa* Ach., var. *pallida* Ach. and var. *pellaea* Ach., all coined by Acharius in 1803. No material bearing these names could be found in the Acharian collections in H-ACH, BM-ACH or UPS-hb. Agrelius. Furthermore, Acharius (1803) synonymized his var. *pallida* with "*Verrucaria pallide-fusca* Hoffm." and var. *pellaea* with "*V. fusca* Hoffm." Both of Hoffmann's names were published without a clear indication of rank (Hoffmann, 1796), and their type materials remain unknown. (See also the comment by Isoviita [1966: 237] on Hoffmann's ambiguous nomenclature.) It is immaterial to speculate whether or not Acharius meant his varieties as new, or whether he regarded them as new names for Hoffmann's undefinable taxa, because Hoffmann's names, in in any case, lack priority (Art. 35.2). The important thing is that [var.] *allophana* was a superfluous name when published. It should be noted that var. *pellaea* was indicated as a saxicolous lichen in the protologue, but var. *allophana* was only noted to be corticolous. *Lichen pallidus* Dickson (1790), also cited under var. *allophana*, is a later homonym (non Schreber [1771], = *Lecanora pallida* (Schreber) Rabenh.; see Imshaug & Brodo, 1966) and, according to Zahlbruckner (1928), belongs to *L. intumescens* (Rebent.) Rabenh.

It seems impossible to unambiguously replace var. *allophana* with any varietal name cited in the protologue, even though in his discussion, Acharius regards morphs sharing certain characteristics of var. flexuosa as representing adult or old states of var. allophana. Lecanora subfusca [f.] g. allophana Ach., Syn. Lich. 158. 1814, likewise remains homotypic with var. allophana. Thus, it seems necessary to drop Acharius' var. allophana from use. However, by virtue of Art. 72, Note 1, we can adopt the epithet allophana at the rank of species as follows:

Lecanora allophana Nyl., Flora 55: 250. 1872. Lectotype (new): "Suecia" (= Sweden), under L. subfusca g. allophana (H-ACH 1143 A).

The typification agrees with the general usage of allophana although the thallus is unusually thick and verrucose. Nylander (1861: 160) also studied this material.

Motyka (1977), without realizing the problems discussed above (see Art. 7.11), selected a lectotype for L. subfusca var. allophana from among the Acharian specimens preserved in UPS-hb. Agrelius. It belongs to the L. pallida group close to L. carpinea (probably L. leptyrodes). The typification by Motyka can be superseded because it can be said to be in serious conflict with the protologue (Art. 8).

2. Parmelia subfusca [var.] η. P. *argentata* Ach., Meth. Lich. 169. 1803. Type (from the protologue): "... cum priori" [= var. pallida"... in cortice arborum"] Lectotype: locality uncertain (see discussion below) (H-ACH 1189 A). Lecanora argentata (Ach.) Malme, Lichenes suecici exsiccati no. 5. 1897.

The name Lecanora subfusca var. argentata has been used by several authors (see Zahlbruckner, 1928), but the original meaning of the name is open to discussion. Magnusson (1932), referring to Vainio (probably 1881: 156), stated that there was no original Acharian material in H-ACH, and he coined the name L. subfuscata H. Magn.[1] for a species "which has been called L. argentata or L. subfusca typica by many authors."

It is true that the material in H-ACH under L. subfusca a. argentata is heterogeneous. Th. Fries (1871:242) referred to this material and specifically excluded the admixed specimens of L. glabrata and L. intumescens from the concept of var. *argentata*. He indicated that the apothecial size of var. *argentata* is 1-1.5 mm, thus effectively eliminating all the Acharian specimens except one.

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[1] When describing L. subfuscata, Magnusson (1932) failed to designate any type material. In his herbarium, however, he had marked the following collection as "Typus" (studied and annotated by him on 8 October 1931), and it is accepted here as the lectotype: Sweden. "Dalsland, Bäcke sn, Hjulserud, å trad (on trees), 12/5 1914 leg. S. & C. Bergstrom" (UPS). Chemistry (TLC): atranorin, gangaleoidin and "californin" (see Brodo, 1984).

We are then left with an excellent specimen of what we have come to know as *Lecanora subfuscata* H. Magn. as a choice for a lectotype (H-ACH 1189 A). It is most probable that the locality designation "Suecia" and not "Helvetia" refers to this specimen, but the year of its collection is not known for certain.

In discussions of the concept of var. *argentata* and its typification, it has generally been overlooked that in the protologue Acharius (1803) mentioned "*Verrucaria argenteo-fusca* Hoffm." in synonymy. The diagnoses of these taxa resemble each other closely enough so that there arises the question: was Acharius, rather than describing a new variety, simply giving a new name to Hoffmann's lichen? The type of *argentata* would, thereby, be the type of *V. argenteo-fusca*. We reject this argument for the following reasons:

Hoffmann's "*V. argenteo-fusca*" was published without a clear indication of rank (Hoffmann, 1796). In its placement within the list of species without ordinal, it appears to be a *taxon vagum* ("Varieteten, Halbarten (subspecies), auch Arten, welche ich als solche aufzuführen noch unentschlossen war ..."). As noted above under *L. allophana*, Hoffmann's nomenclature is well-known to be very ambiguous (Isoviita, 1966). Under the Rules (Art. 35.2), a taxon published without clear indication of rank is inoperative as regards priority. Furthermore, no type material is known to exist for *V. argenteo-fusca* nor is the meaning of the taxon clear (the diagnosis is so general it could apply to any number of lecanorine crustose species). We have therefore concluded that it would be unwise, and indeed unnecessary, to neotypify Hoffmann's lichen. To drop *argentata* from use on the basis of its being a nomen novum for *argenteo-fusca* and therefore untypifiable at present would be, at best, a temporary solution, and could open the door to further nomenclatural changes should the type ever be found or assigned as a neotype. Furthermore, the desire of Acharius to use var. *argentata* as an "avowed substitute" (i.e., nomen novum) of *argenteo-fusca* is very difficult to establish without any direct indication of intent in Acharius' protologue.

If var. *argentata* is accepted as legitimate and typified with the H-ACH specimen mentioned above, we are left with the question as to which epithet, *argentata* or *subfuscata*, should apply at the species level. Zahlbruckner (1928) lists two authors as having used the combination *Lecanora argentata*: Röhling (1813: 82) and Arnold (1884: 326). Both these authors, however, used the epithet for an infraspecific category of *L. subfusca*, not as a species. Malme, in his "Lichenes suecici exsiccati," however, did effectively publish the combination in 1897. (Although printed schedae were not issued separately by Malme, this was not required for effective publication prior to September 1953 [Art. 31].) Degelius (as Nilsson, 1929 and 1931) also treated *L. argentata* as a species, attributing the combination to Röhling (probably misled by Zahlbruckner's citation). This would mean that the epithet *argentata* was validly combined at the species level at least three times before *L. subfuscata* was introduced and, unfortunately, has to be taken up for this well known lichen.

3. *Lecanora subfusca* [var.] θ. *L. atrynea* Ach., Lich. Univ. 395. 1810. Type (from the protologue): "... in saxis et montibus Sveciae, Silesiae, *Mosig*. Helvetiae, *Schleicher*." Lectotype: "Helvetia" [Schleicher no.] 384 (H-ACH 1148). Chemistry (TLC): atranorin, roccellic acid, unidentified triterpene turning pink after charring with H_2SO_4, R_f classes 6-7, 7, 7 in solvents A, B and C (see Culberson, 1972). *Lecanora atrynea* (Ach.) Nyl., Flora 55: 250. 1870.

The specimen we selected is most probably from "Helvetia" and collected by Schleicher, even if Acharius' notation on the sheet is somewhat ambiguous. The specimen is a rather dark-fruited lichen, conspecific with *L. cenisia*. It agrees in all respects with the classical concept of the latter species except in disk colour, and agrees entirely with the type of *L. cenisia* in its chemistry.

4. *Parmelia subfusca* [var.] θ. *campestris* Schaerer, Lich. Helv. Spicil. [pars II, sect. VIII] 391. 1839. Type: None mentioned. *Lecanora subfusca* [var.] θ. *campestris* (Schaerer) Schaerer, Enum. Crit. Lich. Europ. 75. 1850: "Ad saxa arenaria circa Bernam. *Schaer*." Not typified; no original material seen in G. *Lecanora campestris* (Schaerer) Hue, Bull. Soc. Bot. France 35: 47. 1888.

If no type material of this well-known species turns up at a later date, a neotype should be selected for it. A specimen issued in Hepp's Flechten Europas exsiccata (no. 63) in 1853 as *Lecanora subfusca* θ. *campestris* can probably be considered to be authentic. Several specimens of this number from G were examined, and all were found to correspond exactly with the general concept of the species (with a non-inspersed epihymenium, small crystals filling the amphithecium, a narrow, well-defined amphithecial cortex and with small spores). The chemistry was also essentially the same as that found in European and American specimens: atranorin and the unknown Lcm-1 (Brodo,1984).

5. *Lecanora subfusca* [var.] ζ. *L. cateilea* Ach., Lich. Univ. 394. 1810. Type (from the protologue): "... in

saepimentis ligneis Sveciae. Swartz." Holotype: "Svecia" (= Sweden), on lignum (H-ACH 1192). Chemistry: apothecial sections PD+ deep yellow, KOH+ pale yellow, disks C- (TLC not run). Spores 12(-16):nae. Lecanora cateilea (Ach.) Mass., Rich. Lich. Crost. 9. 1852.

The specimen on wood in the Acharian collection is clearly the one described in the protologue. The others, on bark and from "Helvetia", must have been added later, and belong to L. chlarotera Nyl. s. lat. Lecanora cateilea is a member of the L. pallida group (see Imshaug & Brodo, 1966).

6. Lecanora *cenisia* Ach., Lich. Univ. 361. 1810. Type (from the protologue): "... ad rupes in monte Cenisio." Holotype: [France] "Mons Cenis" (H-ACH 1101). Chemistry (TLC): atranorin, roccellic acid, trace of an unknown fatty acid, and the unidentified triterpene mentioned under atrynea above.

Other than being especially robust in thallus thickness and apothecial diameter and in being quite heavily pruinose, the specimen fits the generally accepted concept of the species well. It comes close, morphologically, to L. californica Brodo (see Brodo, 1984), but the latter has a very special chemistry not found in any other species in the subfusca group.

Based on the size of the apothecia and thickness of the paraphyses, Motyka (1977) regarded the type to be quite different from the taxon normally given this name and, in fact, said that the name cenisia should only be applied to the population on Mont Cenis in France. We do not agree, because one can see some intergradation with the more normal-looking cenisia even on the type itself, and robust specimens have been seen from other localities.

7. Lecanora distincta [var.] β. L. *chlarona* Ach., Lich. Univ. 397. 1810. Type (from the protologue): "... ad arborum cortice Sveciae, Helvetiae. Schleicher." Lectotype: "Helvetia" [Schleicher no.] 179a (H-ACH 1145, designated with an arrow and a circled "C"). Lecanora chlarona (Ach.) Nyl., Flora 55: 250. 1872.

There is an abundance of material under the name L. subfusca var. β. chlarona in H-ACH, but it was not easy to select the type. Following the protologue, one could choose virtually any non-pruinose member of the subfusca group. In fact, most of the material is referable to L. chlarotera Nyl. or L. rugosella Zahlbr. On one piece of bark (H-ACH 1145), a small thallus was found corresponding to the current concept of the species (PD+ red apothecial margins, broadly ellipsoid spores, inspersed epihymenium) and so this thallus has been designated as the lectotype. So circumscribed, L. chlarona becomes a synonym of L. pulicaris (see discussion under that epithet), and agrees with the definition adopted by Nylander and accepted by Magnusson (1932, 1946). Selecting the type among the elements corresponding or allied to L. chlarotera (as was suggested by Motyka [1977] without, however, marking the proposed specimen in H-ACH) would badly upset the nomenclatural stability reached through the works of these and later authors in this group. Motyka's concept of L. chlarona remains obscure because he further indicated that the hymenium of L. chlarona should be lacking granules in contrast to L. chlarotera, in which they are small.

8. Lecanora subfusca [var.] *β. coilocarpa* Ach., Lich. Univ. 393. 1810. Type (from the protologue): "... in epidermide Betulae albae Sveciae." Lectotype: "Suecia" (= Sweden)(H-ACH 1191). Chemistry: apothecial margin PD+ red. L. subfusca [subsp.] *coilocarpa (Ach.) Nyl. in Norrlin, Notiser Sällsk. Fauna Flora Fenn. Forh. 13: 330. 1873 (preprint). L. coilocarpa (Ach.) Nyl. in Norrlin, Meddel. Sällsk. Fauna Flora Fenn. 1: 23. 1876.

The characterization of the substrate leaves only one specimen in H-ACH to be chosen as the lectotype of this well-known species. It, unfortunately, corresponds to L. pulicaris. The second specimen of the two on the sheet is also on birch but from "Lusatia" and is also L. pulicaris. Lecanora coilocarpa (Ach.) Nyl., therefore, must become a synonym of that species requiring us to find a new name for the common, dark-fruited, PD- lichen. Because it is so well-known throughout the boreal zone in Eurasia and North America, we are renaming L. coilocarpa s. auct. plur. after its geographic distribution:

Lecanora circumborealis Brodo & Vitik., sp. nov.

Thallus albidus, laevigatus vel subrugosus, saepe prothallo atrocinerascente limitatus, sorediis destitutus. Apothecia sessilia vel ad basin constricta, 0.4-0.8(-1.5) mm diam., margines laevigati. Disci atrofusci aut rufofuscescentes vel nigri, epruinosi. Cortex distinctus, gelatinosus, 22-38 µm latere, 35-65(-90) µm ad basin expansus, amphithecium crystallis magnis instructus. Epihymenium granulis parvissimis inspersus. Sporae octonae, (11.0-)13.0-17.5 x (7.0-)9.0-11.0(-12.0) µm, late ellipsoideae. Atranorinum et saepe acidum roccellicum in thallo apotheciisque continentur. Corticola vel lignicola.

Thallus whitish, continuous, smooth to rough, not sorediate, thallus margin often with a black prothallus. Apothecia sessile, rarely becoming somewhat constricted at the base, 0.4-0.8(-1.5) mm in diameter; disks mostly medium to dark brown, but often pale brownish orange, reddish brown or black, epruinose. Apothecial cortex gelatinous, inspersed, distinct, usually markedly expanded at the base, 22-38 µm laterally, 35-65(-90) µm at the base; amphithecium *pulicaris*-type with large crystals, but crystals may be few or sometimes absent; epihymenium *pulicaris*-type, pigmented brownish orange to olive-brown, with very small granules between the paraphyses (up to 20 µm). Spores broadly ellipsoid, (11.0-)13.0-17.5 x (7.0-)8.0-11.0(-12.0) µm, eight per ascus, spore wall thick. Chemistry: atranorin and usually roccellic acid. Corticolous, lignicolous or rarely saxicolous.

Holotype: Finland. Prov. Tavastia australis. Padasjoki, supra ramos betulae, 1873 J.P. Norrlin (as *L. chlarona* var. *coilocarpa* (Ach.) Nyl., Norrl. & Nyl., Herb. Lich. Fenn. 134(a), H).

This species is closely related to *L. pulicaris*. The negative PD reaction in the apothecial margin does not, by itself, separate the two species because there are specimens of *L. pulicaris* with the same PD- reaction. Other characteristics, for example the larger spores with thicker walls, are then needed to distinguish *L. circumborealis* from *L. pulicaris*. There is a more extensive discussion of the variability and delimitation of *L. circumborealis* in Brodo (1984).

9. *Lichen* *epibryon* Ach., Lich. suec. Prodr. 79. 1798. Type: see discussion below. *Lecanora epibryon* (Ach.) Ach., Lich. Univ. 396. 1810.
   Lichen hypnorum Wulf. in Jacq., Collect. Bot. 4: 233. 1790, nom. illeg. (Art. 64.1), non *Lichen hypnorum* Vahl (1787) (=*Psoroma hypnorum* (Vahl) S.F. Gray).

Acharius (1798) published his *Lichen epibryon* as a nomen novum for *Lichen hypnorum* Wulf. Arnold (1882: 161) identified authentic material of the latter in the herbarium of Wulfen in Vienna as *Lecanora subfusca* var. *hypnorum* but this material could not be located in W now.

10. *Lecanora atra* [var.] β. *L.* *expansa* Ach., Lich. Univ. 345. 1810. Type (from the protologue): "... in saxis Sveciae - Helvetiae. *Schleicher*." Lectotype: "Helvetia" [Schleicher no.] 502 (H-ACH 1031).

Nylander (1861: 161) considered the material from "Helvetia" in the Acharian herbarium as being the type. All specimens so marked are typical examples of *L. campestris* and not *L. atrynea* (= *L. cenisia*) as he suggested. The epithet *expansa* was never combined at the species level, and so it does not have priority over *L. campestris*.

11. *Lecanora* *farinaria* Borrer in Hooker, Suppl. Engl. Bot. 2: tab. 2727. 1834. Type (from the protologue): England, Sussex, Hurstpierpoint, Danny sandfields, on wood. *Borrer*. Holotype: "Danny sandfields, Hurst. ex

herb. Borrer" (K[BM]).

Laundon (1963) gives an excellent description of the type of this sorediate, lignicolous species. We can only add that the epihymenial granules are of the pulicaris-type (very fine, between the tips of the paraphyses), the epihymenium turns a deep orange with concentrated HNO_3 and there are no large crystals in the amphithecium. According to an annotation on the specimen, P.W. James found large quantities of atranorin and a trace of an unidentified substance by TLC. We found roccellic acid in addition to atranorin.

To judge from its anatomy and chemistry, L. farinaria is very closely related to L. circumborealis.

12. Lecanora *gangalea* Ach., Syn. Meth. Lich. 152. 1814. Type (from the protologue): "... in Helvetia supra saxa." Lectotype: "Helvetia" [Schleicher no.] 401 (H-ACH 1174).
    L. gangalea [f.] b. rudis Ach., Syn. Meth. Lich. 152. 1814. Type (from the protologue): "... in saxis Helvetiae." Lectotype: "Helvetia" [Schleicher no.] 570 (H-ACH 1174).

There is little doubt that these are the fragments referred to in the protologues . Both thalli are identical in their essential features: Thallus thick, rimose-areolate; apothecia sessile to emergent (i.e., at first embedded); disks very dark red-brown, margins thick, even, persistent; apothecial margin cortex distinct, heavily inspersed, gelatinous at the base; epihymenium pigmented red-brown, not inspersed or granular; amphithecium either with few large crystals (f. gangalea) or with none at all (f. rudis); spores 13.0-16.4 x 6.2-7.8 µm. Chemistry: atranorin, an unknown substance, and some unidentified fatty acids (not roccellic or nephrosteranic acids, which are known in other species of the L. subfusca group [Brodo, 1984]); margin K+ yellow, PD+ light yellow.

The species seems related to L. gangaleoides Nyl., but differs markedly in chemistry, the colour of the disks, and in the development of the apothecia. Th. Fries (1871: 241) regarded L. gangalea to be a saxicolous form of "L. coilocarpa (auct.)"(= L. circumborealis), and this is where it was placed by Zahlbruckner (1928: 431).

13. Lecanora subfusca [var.] γ. L. *glabrata* Ach., Lich. Univ. 393. 1810. Type (from the protologue): "... in truncis Fagi Sveciae; Helvetiae, Schleicher." Lectotype: "Helvetia" [Schleicher no.] 49a (H-ACH 1192). Lecanora glabrata (Ach.) Malme, Lichenes suecici exsiccati no. 211. 1911.

The fragment we have chosen as a lectotype is on what appears to be *Fagus* bark and is from Switzerland, as indicated in the protologue. It conforms in all respects with the commonly held concept of the species. No material from Sweden was found in H-ACH.

14. *Lecanora subfusca* [var.] δ. *L. horiza* Ach., Lich. Univ. 394. 1810. Type (from the protologue): "... ad corticem Pini Piceae, Aesculi et aliorum arborum Lusatiae, *Mosig*. Galliae, *Dufour*, *Persoon*." Lectotype: "Gallia, *Dufour* 73" (H-ACH 1193). *Zeora horiza* (Ach.) Flotow, 27. Jahresber. Schlesisch. Ges. für Vaterl. Kultur 124. 1849. *Lecanora horiza* (Ach.) Lindsay, Trans. Bot. Soc. Edinburgh 9: 96. 1869.

Nylander (1861) excluded one of the elements named as δ. *horiza* in the Acharian herbarium (H-ACH) from its typification, namely Mosig's collection of *Maronea constans* (Nyl.) Th. Fr. from Lusatia (= Lausitz, DDR; not "Lusitania" as Nylander erroneously wrote). For the remaining material, he first applied the name *L. subfusca* f. *rugosa* based on *Lichen rugosus* Pers. ex Ach. but noticed at a later date that the material was still heterogenous. After excluding the "*rugosa*" material (= *L. rugosella*; see discussion under *Lichen rugosus*), he then left the specimen collected or sent by Dufour from Gallia as the type of *horiza*. The specimen is, in fact, annotated as "*horiza*" by Nylander on the Acharian sheet. This specimen was recognized by Nylander as a synonym of his *L. parisiensis* (Nylander, 1896), and it does agree both morphologically and chemically with the lectotype of the latter species (France. Paris, Bagneaux, *W. Nylander* [H-NYL 27674]). The type of *parisiensis* contains (besides atranorin) traces of two unknown triterpenes known in other species of the *subfusca* group, especially *L. grantii* H. Magn., substances that can be called Lgr-1 and Lgr-2 (Brodo, 1984). The type of *horiza* contains a trace of Lgr-1 as well as another unknown (Lcm-1) characteristic of many specimens of *L. parisiensis* and diagnostic for *L. campestris* (see Brodo, 1984).

Motyka (1977) regarded the Persoon specimen of "*Lichen rugosus*" as the type of var. *horiza* and thereby concluded that *L. horiza* should be used instead of *L. rugosella*, which he considered as a nomen nudum. The discussion above, and under *Lichen rugosus*, should make it clear that Motyka's approach is not to be followed.

15. *Lecanora miculata* Ach., Syn. Meth. Lich. 164. 1814. Type (from the protologue): "... in America septentr. ad corticem arborum." Lectotype: "Amer. septentr. Muhlenberg 18:2"(H-ACH 1070; isotype UPS-hb. Agrelius). Chemistry: not tested.

The lectotype of this North American endemic has the same UV (long wave) orange fluorescence in the heavily pruinose apothecial disks as is seen in specimens from North American herbaria. There was too little material on the type to permit its examination by TLC. The species, however, is consistent in producing atranorin, zeorin and lichexanthone (Brodo, 1984).

16. *Parmelia subfusca* [var.] ε. *Pinastri* Schaerer, Lich. Helvet. Spicil. 390. 1839. Type (from the protologue): "exs. n. 310." Isosyntype: Switzerland, "ad Pinum sylvestrem in uliginosis der Löhr", (BM, H). *Lecanora pinastri* (Schaerer) H. Magn., Meddel. Göteborgs Bot. Trädg. 7: 82. 1932.

The type is a minor lignicolous variant of *L. pulicaris*, and *L. pinastri* should be considered a synonym of that species. The thallus is essentially endoxylic, with little showing on the surface. Its apothecia are small, almost black, with margins that are thick, persistent, smooth and even, and react PD+ deep red in section.

17. *Patellaria pulicaris* Pers., Ann. Wetter. Ges. 2(1): 13. 1810. Type (from the protologue): "... ad ligna abietina in Hercynia." Holotype (?): "Hercynia" [= Germany, Harz] (L 910.182 - 1000). *Lecanora pulicaris* (Pers.) Ach., Syn. Meth. Lich. 336. 1814. *Lecanora chlarona* f. *pulicaris* (Pers.) Poelt, Berichte Bayer. Bot. Ges. 29: 66. 1952.

The type specimen is a well-developed lichen with many apothecia, growing on wood. The thallus is thin, but in continuous patches, each patch surrounded by a black, very thin prothallus. The apothecia are dark red-brown to almost black and are closely adnate to partly immersed. The margins are thin, smooth and even. The apothecial sections are KOH+ yellow and PD+ red in young apothecia, although PD- in some older ones. The apothecial margin cortex is composed of radiating thick hyphae inspersed with granules, and is only about 35 µm thick at its thickest point. The epihymenium has fine granules between the paraphyses tips. The spores are 12.4-14.3 x 7.5-8.5 (-9.5) µm.

Correctly regarded as a synonym of *L. chlarona* by Poelt (1952) (as a form differing in its darker apothecia and lignicolous substrate), the name *pulicaris* must replace *chlarona* at the species level.

18. *Lecanora subfusca* [var.] ε. *L. rufa* Ach., Lich. Univ. 394. 1810. Type (from the protologue): " ... in cortice Quercus et ligno vetusto Galliae, *Persoon*; Lusatiae, *Mosig*." Lectotype: Gallia, Pers[oon no.] 79" (H-ACH 1191). *Lichen rufus* Pers. ex Ach., Lich. Univ. 394. 1810 (nom. nud., in synon.), non *Patellaria rufa*

Pers. (1811).

The material from "Lapponia" under this name in the Acharian herbarium is *Rinodina conradii* Körb., as was already pointed out by Th. Fries (1871: 241). Fries recognized the remainder (from "Gallia") as typical "var. *glabrata*", effectively designating it as the lectotype. (No material from "Lusatia" could be found in H-ACH.) *Lecanora subfusca* [var.] ε. *rufa* was never raised to the species level, and two binary combinations of the epithet "*rufa*" already exist in the genus *Lecanora*: *L.* *rufa* Fée (= *Lopadium* fide Zahlbruckner [1926]), and *L.* *rufa* Migula (= *Aspicilia* fide Zahlbruckner[1928]). Thus the name will not have to replace the well-established and understood *L.* *glabrata* (Ach.) Malme.

19. *Lichen* *rugosus* Pers. ex Ach., Lich. Univ. 394. 1810 (nom. inval., Art. 34, pro syn. *Lecanora* *subfusca* var. *horiza* Ach.); non *Lichen* *rugosus* L. 1753 (= *Ascodichaena* *rugosa* Butin; see Hawksworth, 1983). *Lecanora* *subfusca* f. *rugosa* Nyl., Lich. Scand. 160. 1861. *Lecanora* *rugosa* (Nyl.) Nyl., Flora 55: 250. 1872 (nom. illeg. Art. 64.1; non Ach. 1810). *Lecanora* *rugosella* Zahlbr., Catal. Lich. Univ. 5: 524. 1928. *Lecanora* *chlarotera* f. *rugosella* (Zahlbr.) Poelt, Ber. Bayer. Bot. Ges. 29: 68. 1952. Lectotype: "L. rugosus Pers. Gallia, Pers[oon no.] 86" (H-ACH 1193). Chemistry (TLC): Atranorin, gangaleoidin and a trace of an unidentified substance.

When describing *L.* *subfusca* var. *horiza*, Acharius (1810) mentioned in synonymy "*Lichen* *rugosus* Pers.", a manuscript name accompanying a specimen sent to him by Persoon. Nylander (1861) consulted the H-ACH material and accepted and described the Persoon material as *Lecanora* *subfusca* f. *rugosa*. Because "*Lichen* *rugosus* Pers." was never validly published, having been mentioned only in synonymy (Art. 34), Nylander's publication of *Lecanora* *subfusca* f. *rugosa* in 1861 must be regarded as the first valid publication of the epithet based on Persoon's material. "*Lichen* *rugosus* Pers." was, in any event, a later homynym of *Lichen* *rugosus* L. (1753) (see above), and therefore would have been illegitimate even if it were regarded to have been validly published. In 1872, Nylander accepted his f. *rugosa* at the rank of species, but the resulting combination, *Lecanora* *rugosa* (Nyl.) Nyl., was a later homonym of *Lecanora* *rugosa* Ach. (1810) (= *L.* *rupicola* (L.) Zahlbr.) Zahlbruckner (1928: 524), noting this fact, introduced the new name *L.* *rugosella* Zahlbr. for "*L.* *rugosa* Nyl." Oddly enough, he at the same time accepted *L.* *subfusca* var. *rugosa* as an independent taxon and credited it to Nylander (1861). Zahlbruckner's treatment must be considered a bibliographic error: Nylander did not introduce a variety but a form, and not on page 161 but on 160. The first combination of *rugosa* as a variety probably is L. subfusca var. rugosa (Nyl.) Th. Fr., Lich. Scand. 240. 1871.

The lectotype of L. subfusca f. rugosa Nyl., which becomes the type of L. rugosella Zahlbr., has the coarsely verrucose-granulose thallus and apothecial margins known for the species. The chemistry agrees with the European material of the taxon, but North American populations are somewhat different (Brodo, 1984).

20. Lecanora *scrupulosa* Ach., Lich. Univ. 375. 1810. Type (from the protologue): "... ad corticem arborum Helvetiae. Schleicher." Lectotype: "Helvetia. [Schleicher no.] 816" (H-ACH 1124).

The specimen in H-ACH is in very poor condition and is indeterminable. The epihymenium has been destroyed and there are no spores; however, large crystals are present in the amphithecium. The material in UPS-hb. Agrelius under this name may be a fragment of the H-ACH specimen and cannot be identified either; and no type material could be found in Schleicher's herbarium in LAU. Nylander (1861: 162) considered "L. subfusca **** L. scrupulosa" (rank indefinite) to have pale, whitish pruinose apothecia, and to be "almost united with L. albella". His mention of a specimen "Ad fraxinum in Suecia (ex hb. Ach.)" is an error for var. melioica. Th. Fries (1871: 241) mentions this species under var. rugosa as a "somewhat abnormal form with small, immerse and not well-developed apothecia." The identity of this species, then, remains unknown.

21. Lichen *subfuscus* L., Species Plantarum 2: 1142. 1753. Type (from the protologue): "... in Europa, arboribus & rupibus innascens." Lectotype: Dillenius, Historia Muscorum, 1742, pl. XVIII, fig. 16.B.; "Typotype" (see Stearn, 1957: 129) hb. Dillenius: Lichenoides ... subfuscis, Tab. XVIII, f. 16, second specimen from left, main thallus (OXF). Lecanora subfusca (L.) Ach., Lich. Univ. 393. 1810.

Until Magnusson's (1932) revision, most authors had used the name Lecanora subfusca (L.) Ach. in a collective sense together with a series of infraspecific taxa. The "typical" subfusca was left undefined, or was regarded to be the variety argentata or allophana (see comments below). Magnusson (1932), indeed, recommended abandoning the epithet "subfusca" altogether, along with argentata, and replacing it with L. subfuscata H. Magn. As we have already pointed out, it is not necessary to drop "argentata" since the name is typifiable from material in Acharius' herbarium. Finding a suitable and acceptable type for Lichen subfuscus, however, is considerably more difficult.

To begin with, the specimens in the Linnaean herbarium labelled Lichen subfuscus cannot be used for lectotypification. Linnaeus (1753) made two citations in his protologue, one to "Fl. Suec. 943" (species no. 943 in Flora Svecica, 1745), and the other to "Dill. musc. 134. t.18 f.16" (Dillenius, Historia Muscorum, plate XVIII, fig. 16). None of the specimens in the Linnaean herbarium bears any reference to either of these two works, nor do they bear any date of collection or identification (Savage, 1945). According to Savage (1945), several of the specimens have been annotated by "L.f." (Linnaeus' son) and Dickson (a later botanist), and indications are that the specimens postdate the publication of Species Plantarum (see the comments of Krog & James, 1977: 25). That they correspond at least in part to var. allophana, according to Vainio (1886) and Crombie (1894), is therefore of no particular significance.

We are then left to typify Lichen subfuscus in accordance with Article 9 of the Botanical Code, permitting the selection of an illustration or figure as a type in the absence of a specimen. In this case, the illustration would be Dillenius' figure in Historia Muscorum. Two drawings are found under Fig. 16, labelled "16.A." and "16.B." Both are non-descript circles on a crust depicted as growing on pieces of bark. The drawings could illustrate any one of several species of Lecanora subfusca aggr. or, indeed, other types of lecanorine crustaceous lichens. The illustrations and the accompanying description alone, therefore, do not help us establish the identity of Lichen subfuscus.

To find out what Dillenius was illustrating in Figs. 16A and 16B, we can consult the specimens in Dillenius' herbarium (OXF) as, for example, Krog & James (1977) did for Lichen calicaris in their typification of that name. In the case of the Ramalina, the protologue was detailed enough and the relationship between illustration and specimen was clear enough to enable the authors to make a logical and agreeable typification. In the case of Lichen subfuscus, it is not so easy.

The Dillenian material consists of six elements on five fragments. Included are Lecanora allophana, L. glabrata, L. cfr. circumborealis and a Caloplaca (see also Crombie, 1880). The best developed specimens are referable to L. allophana (mentioned also by Crombie, 1894), and one could argue that L. allophana might well correspond to Fig. 16.B. of Historia Muscorum and could serve as a "typotype", to use the terminology of J.E. Dandy (as cited in Stearn, 1957: 129). That is, the lectotype would be the illustration (Plate XVIII, Fig. 16.B., Dillenius [1742]), and the larger part of the second fragment from the left in hb. Dillenius, sheet XVIII under Lichenoides ... subfuscis, although not obviously the material depicted in the illustration, would be considered as the "type" of the type. In this way, we can fix the identity of Lichen *subfuscus* as synonymous with *Lecanora allophana*.

Assuming one accepts such a typification, we must still consider the desirability and the appropriateness of using the name *L. subfusca* to replace *L. allophana*. Several points can be brought to bear on this argument: 1) unlike *Ramalina calicaris*, the name *Lecanora subfusca* has never had a widely accepted and well-understood meaning; 2) it would remove from usage one of the few reliably applied names in the *L. subfusca* group (i.e., *allophana*) and would replace it with a name that has been poorly understood and misapplied for almost 250 years; and 3) although the Dillenian illustration may refer to *L. allophana*, the variety *allophana* has specifically been excluded from the concept of the "typical" or Linnaean *subfusca* since 1803 when Acharius first combined the name in *Lecanora*. Röhling (1813), Crombie (1894), Hue (1903) (who is often credited with having emended the concept of *subfusca*), and Magnusson (1932) among others, all regarded the "typical" *subfusca* to be equivalent to var. *argentata* (see comments under *argentata* above). We therefore recommend that the name *Lichen subfuscus* be considered for the list of nomina rejicienda under Article 69.

Motyka (1977) presents a long discussion on the meaning and typification of *L. subfusca* and concludes that in spite of the fact that "*L. subfusca* was confused from the beginning," it should not be considered as "a confused species." He selected a neotype in herb. Degelius, a specimen that represents *L. allophana* in our interpretation. It should be noted that in the same paper, Motyka (1977) adopts *L. allophana* for quite another species (see discussion under *allophana*). For the reasons mentioned above, we feel that Motyka's typification is not acceptable, and is superseded because original material is available (Art. 8).

22. *Lecanora subfusca* [var.] γ. *L. zosterae* Ach., Syn. Meth. Lich. 158. 1814. Type (from the protologue): "... ad littora marina in foliis exsiccatis Zosterae." Lectotype: "Suecia" (= Sweden) (H-ACH 1147 A; two apparent isolectotypes in UPS-hb. Agrelius). *Lecanora zosterae* (Ach.) Nyl., Flora 59: 577. 1876.

The type material consists of a number of sea grass (*Zostera*) fragments bearing numerous mature apothecia. The specimen is virtually identical to lignicolous material distributed as Lichenes Canadenses Exsiccati no. 125 under the name *Lecanora palanderi* Vain., Arkiv Bot. 8(4): 48. 1909, which, in turn, was said to compare favourably with the Vainio type (Brodo, 1976). Because of the nomenclatural implications of this discovery, the type was reexamined in Turku by I.M.B., and it was noted that the apothecia are coarsely pruinose, and the margins are white rather than brownish. These are variable characteristics in *Lecanora*, however, and perhaps are not significant. We have seen some intermediate specimens growing on moss or lignum from the Yukon and Northwest Territories (Canada) (CANL), and we think it is best to regard the two taxa as conspecific. Because the epithet *zosterae* predates *palanderi* at the species level, *Lecanora zosterae* (Ach.) Nyl. will have to replace *L. palanderi*.

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MYCOTAXON

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NOTES ON NEW REVISIONS OF GREENLANDIC LICHENS II

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SUMMARY

110 specimens of 20 species of Greenlandic lichens have been revised and re-identified. Two of the species, viz. Arthopyrenia sublitoralis (Leight.) Arn. and Rinodina castanomela (Nyl.) Arn., are new additions to the known lichen flora of Greenland. Eight taxa, viz. Baeomyces placophyllus Ach., Lempholemma radiatum (Sommerf.) A. Henss., Lecanora atrosulphurea (Wahlenb.) Ach., L. pachythallina Lynge, Lecidea silacea (Ach.) Ach., Parmelia substygia Räs., Phylliscum demangeonii (Moug. & Mont. in Mont.) Nyl. and Rhizocarpon pusillum Runem., are new to C.W. Greenland. One species, viz. Rinodina cacuminum (Th. Fr.) Malme, is new to S.W. Greenland. Two species, viz. Cetraria nigricascens (Nyl.) Elenk. and Rhizocarpon pusillum Runem., are new to N. Greenland. New localities are given for some rare Greenlandic lichens, for example, Endocarpon pusillum Hedw. and Lecanora maxima Lynge. Comments on the ecology and distribution of the various taxa are provided.

INTRODUCTION

The great revision work on the Greenlandic lichen material deposited in Copenhagen (C) is progressing steadily. This material was strongly extended by the grant of the collections of Dr. Paul Gelting to the Botanical Museum of Copenhagen in the sixties. The lichen collections of Dr. Gelting comprise of more than 50.000 specimens, including collections from Denmark, Sweden and Southern Europe, which have been mounted and labelled under the supervision of the present author during a period of 15 years. Unfortunately, Dr. Gelting only accomplished publication of a small part of this enormous material before his death in February 1964.

This paper deals with selected parts of the above collections, together with some additional specimens collected by P. Eberlin, E. Dahl, J. Feilberg, K. Holmen, B. Lynge and M. Skytte Christiansen. In the summer of 1982 and 1983 J. Poelt and H. Ullrich made extensive collections of lichens in different parts of C.W. Greenland. Some of the specimens collected are included in the present study.

LIST OF SPECIES

ARTHOPYRENIA SUBLITORALIS (Leight.) Arn. -C.W. Greenland: S. Disko, Søndre Laksebugt, 69°19'N 53°54'W, 0 m, on exoskeletons of acorn barnacle on basaltic rocks in upper part of *Fucus*-belt; three specimens, leg. P. Gelting.

Thallus of the present specimens are very thin and somewhat dispersed. Perithecia up to 0.25 mm broad occur abundantly. The species may be distinct from *A. halodytes* (Nyl.) Arn. (Hawksworth, James & Coppins 1980). *It is new to* the lichen flora of Greenland.

BAEOMYCES PLACOPHYLLUS Ach. -C.W. Greenland: S. Disko, Godhavn, 69°15'N 53°33'W, 50 m, on bare, moist morainic clay in heath over NW. -exposed gneissic rocks; one specimen, leg. P. Gelting. -W. Disko, Mellemfjord, 69°41'N 54°27'W, on humus soil; one specimen, leg. P. Gelting, vidi A.H. Magnusson. -E. Disko, Qutdligssat, Kitdlerpait, 70°06'N 53°02'W, 60 m, on dry gravel in old river-bed, between branches of espalier-formed *Salix*, together with *Ochrolechia upsaliensis*; two specimens, *leg.* P. Gelting.

When typically developed, B. placophyllus is easily identified on account of its pale ochraceous to clayey grey thallus, which is distinctly lobate to foliate at the margin and rather densely covered by schizidia. In some Greenland specimens the marginal lobes and the schizidia can be somewhat indistinct, which can make the determination difficult. The chemical reactions of B. placophyllus agree with those of *Baeomyces rufus* (Huds.) Rebent.: K + yellow and P + orange (stictic acid).

B. placophyllus is new to the lichen flora of C.W. Greenland. It is previously known from a few, more southern localities on the west coast (Alstrup 1978) and has also been reported from five localities between c. 72-75°N in E. Greenland. Its distribution can be described as circumpolar, arctic and boreal (Thomson 1979). Thus B. placophyllus is a very characteristic element of the lichen community occurring in the openings in the dwarf shrub heaths of, e.g., the Faroes.

CANDELARIELLA XANTHOSTIGMA (Ach.) Lett. (Syn. C. vitellina (Hoffm.) Müll. Arg. var. xanthostigma (Ach.) Elenk.) -C.W. Greenland: Kangâtsiaq, 68°19'N 53°28'W, 20 m, over dead moss on E. -exposed, seasonally moistened gneissic rock; one specimen, leg. P. Gelting. -S. Disko, Lyngmarksfjeldet, 69°16'N 53°35'W, 50-320 m, on bark of Salix; one specimen, leg. J. Poelt & H. Ullrich. -S. Disko, Fortunebay, 69°16'N 53°44'W, 30 m, on dead plant fragments on E. -exposed gneissic rock; one specimen, leg. P. Gelting.

Both of the specimens mentioned are typical, the thallus consisting of ± widely dispersed, yellow granules (<0.1 - 0.2 mm in diameter). A number of additional specimens from the Disko-Nûgssuaq area, also collected by P. Gelting, appear to belong to other species of Candelariella, e.g., C. placodizans (Nyl.) H. Magn.

Previous records of C. xanthostigma are available from different parts of Greenland (Böcher 1954; E.S. Hansen 1978 b, 1982; Lynge 1923, 1937, 1940). It is a common circumpolar species.

CETRARIA NIGRICASCENS (Nyl.) Elenk. -N. Greenland: East coast of Peary Land, Herlufsholm Strand, 82°40'N ab. 21°W, 75 m, on dry, stony river-bed; one specimen, leg. K. Holmen, det. the present author.

Kärnefelt (1979) points out that C. nigricascens is extremely variable, when growing on the ground. Although the present specimen agrees well with that collected by B. Fredskild and C. Bay at Tugtuligssuaq in Melville Bugt in N.W. Greenland (E.S. Hansen 1981), we cannot conclude from the very few Greenland collections of C. nigricascens that its range of morphological variation is more narrow in Greenland than in other arctic areas. Corticolous specimens of C. nigricascens have not been found in Greenland so far. The distribution of C. nigricascens has been mapped by Kärnefelt (1979). The species is new to N. Greenland.

CETRARIA TILESII Ach. -N. Greenland: North coast of Independence Fjord, Kap Vårbrud, 82°20'N 22°30'W, 30 m, over mosses in place manured by owls on gravelly hill together with, e.g., Physconia muscigena; one specimen, leg. K. Holmen, det. the present author. -East coast of Peary Land, Herlufsholm Strand, 82°40'N ab. 21°W, 75 m, on dry, stony river-bed; one specimen, leg. K. Holmen, det. the present author.

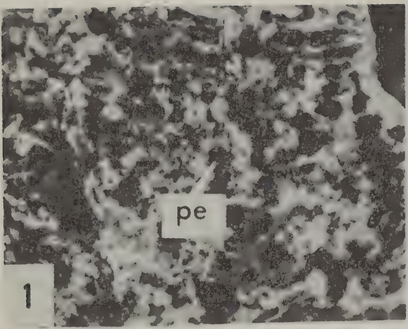
The last specimen in particular is extremely well-developed. It is more loosely attached to the substratum than the specimen reported on as the first from Greenland by E.S. Hansen (1981). The thallus of the arctic "C. tilesii" differs from the more southern taxon occurring on, e.g., Gotland and Øland, being foliose-subfruticose, not distinctly fruticose as the last.

ENDOCARPON PULVINATUM Th.Fr. -C.W. Greenland: S. Disko, Godhavn, 69°15'N 53°33'W, several sites, but all specimens are from basaltic rocks; they are,except one (leg. J. Poelt & H. Ullrich) collected by P. Gelting. -S. Disko, Fortune-bay, 69°16'N 53°44'W, on basaltic boulder in brook; one specimen, leg. P. Gelting. -S. Disko, Igpik, 69°18'N 53°15' W, 30 m, on basaltic bird rock; one specimen, leg. P. Gelting. -Diskofjord, Kuánerssuit, Kvangrotten (Orpit qaqa), 69°35'N 53°25'W, on basaltic rock; one specimen, leg. P. Gelting. -W. Disko: Mellemfjord, Sioranguaq, 69°43'N 54°28' W, 50 m, on basaltic boulder; one specimen, leg. P. Gelting. -Mellemfjord, Narsarssuaq, 69°44'N 54°38'W, 15 m, basaltic boulder in brook; two specimens, leg. P. Gelting. -W. Disko, Nordfjord, Kugssinerssuaq Harbour, 69°55'N 54°25'W, 6 m, two specimens (and three additional specimens from a S. -exposed basaltic rock at another site in Nordfjord), leg. P. Gelting. -E. Disko, Ujaragssuit, 69°58'N 52°50'W, on basaltic rock; one specimen, leg. P. Gelting.

The thallus of the present plants are characterized by their dark brown, ascending and overlapping squamules that are somewhat lobed and up to 6 mm long. Lynge & Scholander (1932) have described the structure of the perithecia. The size of the spores of some of the above specimens are, however, somewhat smaller than stated by these authors. The hymenial gonidia measure 7-10 x 4 μm. In the opinion of J. Poelt this taxon has to be referred to Staurothele instead of Endocarpon (J. Poelt; personal communication).

From the previous literature records from Greenland (e.g., Lynge 1937; Lynge & Scholander 1932) one gets the impression that E. pulvinatum is a very scarce species in Greenland. This statement holds, however, not good for the populations on Disko Island. This arctic-alpine species now appears to be very common in this area and presumably also in other basaltic regions in Greenland.

Fig. 1: Arthopyrenia sublitoralis (Leight.) Arn. Fertile thallus (pe=perithecium) growing on exoskeleton of acorn barnacle in the upper part of the Fucus-belt on a basaltic rock in Søndre Laksebugt (x 12). 2: Baeomyces placophyllus Ach. Central part of sterile thallus with many schizidia growing on morainic clay in a heath near Godhavn. Coll. no. 18085 (x 12). 3: Cetraria nigricascens (Nyl.) Elenk. Lower surface of sterile thallus from a stony river-bed at Herlufsholm Strand. Coll. no. 5644 (x 4.5). 4: Cetraria tilesii Ach. Sterile thallus from a stony river-bed at Herlufsholm Strand. Coll. no. 5653 (x 6). 5: Endocarpon pulvinatum Th. Fr. Fertile thallus growing on a basaltic rock at Kuánerssuit (x 5). 6: Squamules of Endocarpon pulvinatum with immersed perithecia from the same collection (x 12).



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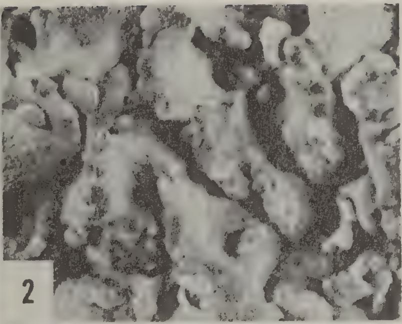

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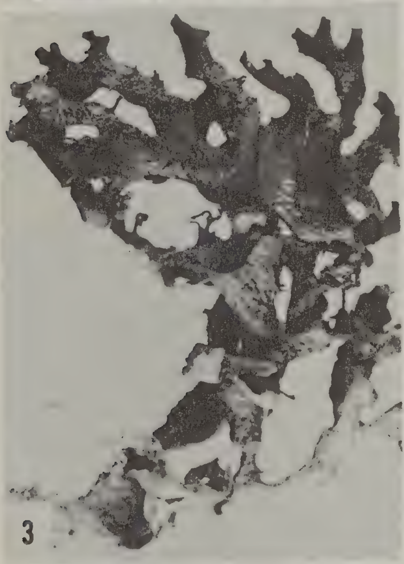

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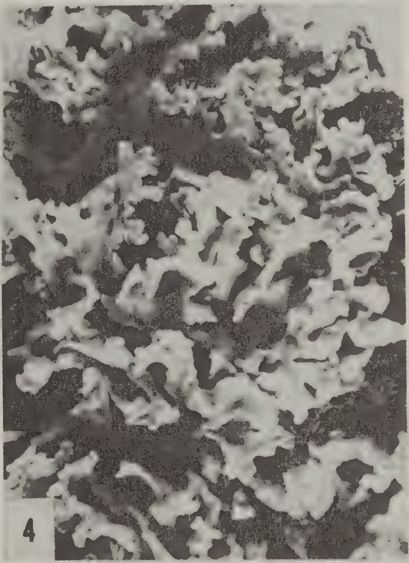

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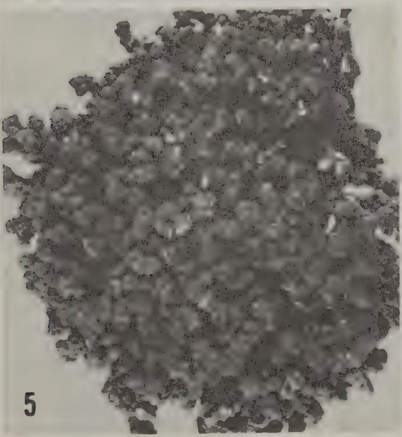

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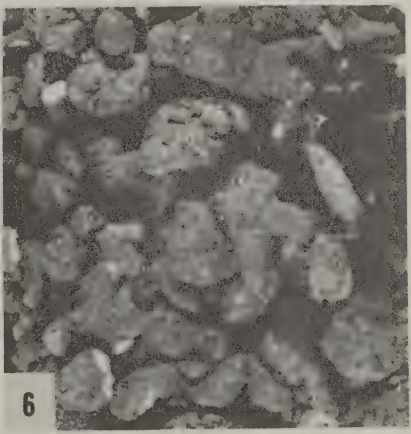

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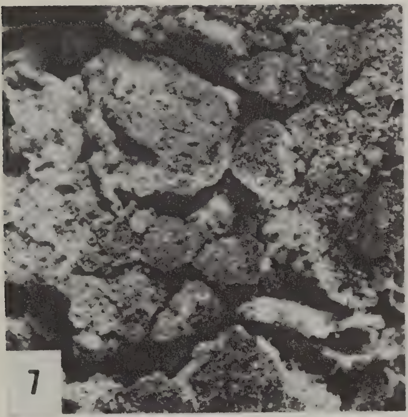
ENDOCARPON PUSILLUM Hedw. -C.W. Greenland: Søndre Strømfjord, 67°01'N 50°43'W, on loess on steppe-like slope; one specimen, leg. J. Poelt & H. Ullrich. -Sarpiussat, 68°34'N 51°23'W, 10 m, on calcareous soil; three specimens, leg. P. Gelting. -Nûgssuaq Peninsula: Atanikerdluq, 70°03'N 52°20'W, 10 m, on calcareous soil on bird rock together with *Psora rubiformis*; one specimen, leg. P. Gelting.

Thallus of the present plants is areolate to squamulose. The areoles (squamules) are greyish brown to dark brown, dull (contrary to the squamules of *Catapyrenium lachneum*) and up to 1.5 mm broad. They are free at the margin, but closely attached to the substratum in the centre. Perithecia occur abundantly. The spores, two per ascus, are brownish and muriform, measuring 29-55 x 18-23 μm (Thomson 1979).

The distribution of E. pusillum is circumpolar, boreal to temperate ranging into the Arctic. There is only one previous record of the species from Greenland (Böcher 1954).

LECANORA ATROSULPHUREA (Wahlenb.) Ach. -S.W. Greenland: "Kangek" at Tasermiut, 60°04'N 45°07'W, on siliceous rocks; two specimens, leg. J. Vahl. -Nanortalik, 60°09'N 45°15'W, on siliceous rocks together with, e.g., *Pseudephebe pubescens*, *Parmelia omphalodes* and *Tremolecia atrata*; two specimens, leg. P. Eberlin. -"Annutuarssuk" at Sermersôq, c. 60°15'N 45°10'W (the exact situation of this (island-) locality is not known, but according to the diary of J. Vahl, in which information is given on his itineraries in Greenland, the locality mentioned is situated close to the island of Sermersôq), on siliceous rock; one specimen, leg. J. Vahl. -Julianehåb, 60°43'N 46°02'W, on siliceous rocks; three specimens, leg. J. Vahl. -Holsteinsborg, 66°56'N 53°40'W, on siliceous rock; one specimen, leg. J. Vahl. -C.W. Greenland: Arfersiorfik Fjord, Tarajornitsoq, 68°08'N 52°10'W, 4 m, on gneissic block on talus slope together with *Umbilicaria hyperborea*; two specimens, leg. P. Gelting, who first identified

Fig. 7: Endocarpon pusillum Hedw. Areoles with immersed perithecia occurring on calcareous soil at Sarpiussat. Coll. no. 19163 a (x 12). 8: Lecanora atrosulphurea (Wahlenb.) Ach. Central part of thallus with numerous apothecia from a siliceous rock at Julianehåb (x 7). 9: Lecanora maxima Lynge. Fertile thallus growing on mosses and gravelly soil at Eqaluarssuit. Coll. no. 14677 (x 6). 10: Lecanora pachythallina Lynge. Fertile thallus growing on dead plant fragments from Itivdliarssuk. Coll. no. 15955 (x 12). 11: Lecidea paupercula Th. Fr. Fertile thallus with more or less dispersed areoles from a gneissic rock on Tupilak Ø. Coll. no. 16774 (x 12). 12: Lecidea silacea (Ach.) Ach. Apothecia (dark) and convex areoles from a siliceous rock at Holsteinsborg (x 16).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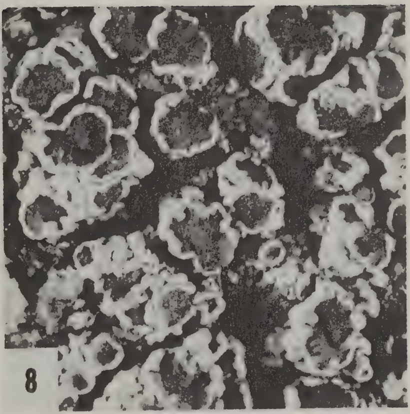
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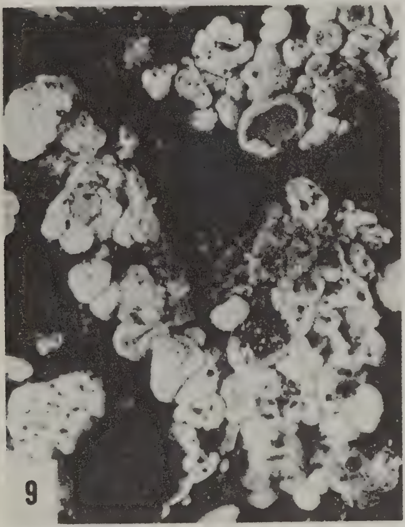
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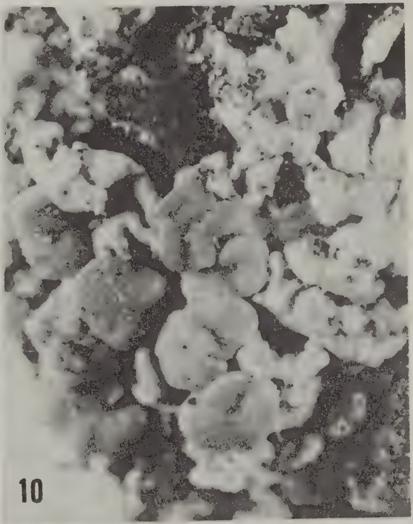
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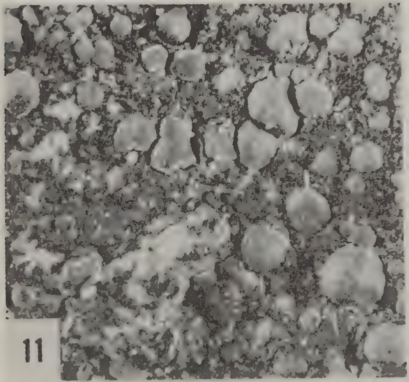
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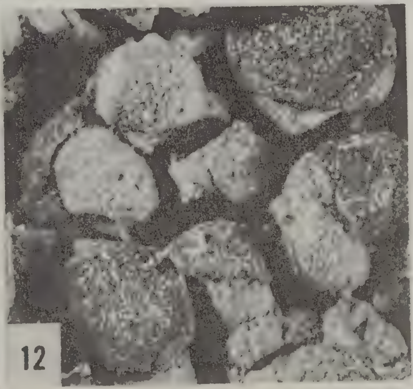
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them as *Lecanora intricata* (Ach.) Ach. and *L. chlorophaeodes* Nyl., respectively. However, Heino Vänskä, who has revised all the Greenlandic collections of Lecanora atrosulphurea, found that these specimens belong to this taxon. He tested the two specimens chemically: they contain usnic acid, thiophanic acid, zeorin and fatty acids,+unknown substance. -Ikamiut, 68°38'N 51°50'W, on siliceous rock; one specimen, leg. P. Gelting. -Egedesminde, 68°43'N 52°50'W, on siliceous rock; one specimen, leg. P. Sørensen. The specimen was tested chemically by H. Vänskä. It contains atranorin, thiophanic acid, zeorin and fatty acids.

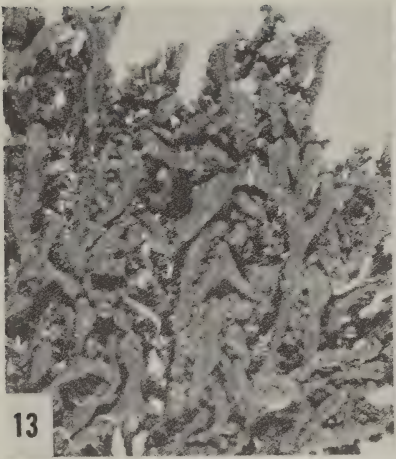
Most of the above specimens are richly fertile. L. atrosulphurea is new to C.W. Greenland. The species is also known from S.E. Greenland (Lamb 1940). Its general distribution is circumpolar according to Thomson (1979).

LECANORA MAXIMA Lynge -C.W. Greenland: Disko, Godhavn, 69°15'N 53°33'W, 75 m, on mosses and soil; one specimen, leg. P. Gelting. -Laksefjord, Eqaluarssuit, 72°29'N 54°28'W, 30 m, over mosses on irrigated, N. -exposed gneissic rock; one specimen, leg. P. Gelting.

The specimens, both of them fertile, agree well with the description given by Lynge (1937). H. Vänskä, who confirmed the determination of the specimen from Godhavn, adds the following chemical information on the species: it contains usnic acid, zeorin, fatty acids and an unknown substance.

There are only two previous records from Greenland of L. maxima, one from Lyngmarken near Godhavn (type collection), the other from Tingmiarmiut in S.E. Greenland (Dahl, Lynge & Scholander 1937). The species is presumably not neglected in Greenland, as it is rather conspicuous by its yellowish white, imbricated thallus squamules. It still must be con-

Fig. 13: Lempholemma radiatum (Sommerf.) A. Henss. Radiating lobes with numerous hormocystangia from a temporarily moistened gneissic rock at Godhavn (x 9). 14: Parmelia substygia Räs. Central part of sterile thallus with punctiform to capitate soralia from Igdluko. Coll. no. 19067 (x 12). 15: Phylliscum demangeonii (Moug. & Mont. in Mont.) Nyl. Thallus with many immersed apothecia from a S. -exposed gneissic rock near Godhavn. Coll. no. 19888 (x 12). 16: Rhizocarpon pusillum Runem. Fertile thallus growing parasitically on Sporastatia testudinea on a stone on a gravelly coast plain at Koralkysten. Coll. no. 5662 (x 6). 17: Rinodina cacuminum (Th. Fr.) Malme. Fertile thallus from a gneiss-wall at Godhavn (x 12). 18: Rinodina castanomela (Nyl.) Arn. Fertile thallus growing on a siliceous rock at Qingartût (x 12).



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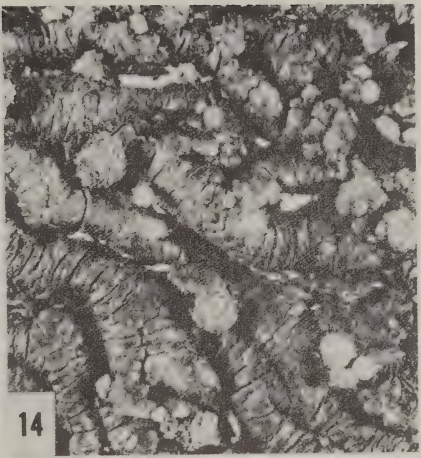

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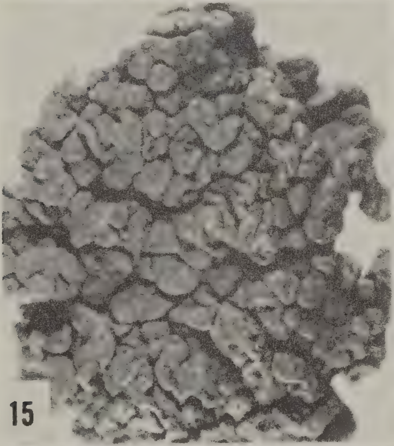

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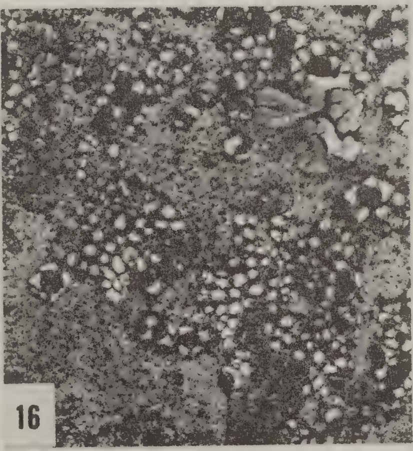

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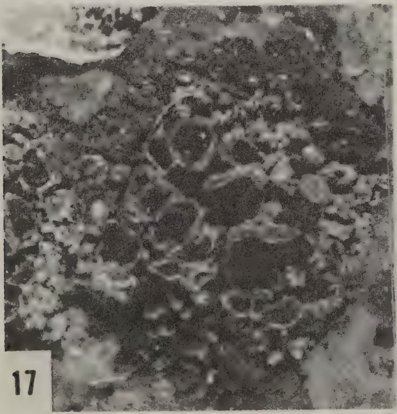

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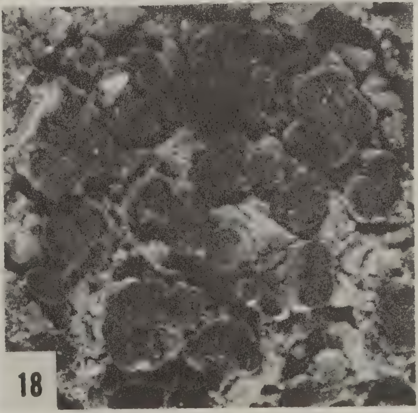

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sidered a rare species outside Disko. L. maxima is also known from North America.

LECANORA PACHYTHALLINA Lynge -C.W. Greenland: Søndre Strømfjord, 66°59'N 50°37'W, c. 100 m, on dry loess near salt lake; one specimen, leg. J. Poelt.-Arfersiorfik Fjord Itivdliarssuk, 67°55'N 50°40'W, on dead plant fragments; one specimen, leg. P. Gelting (determination confirmed by I. Brodo). The plant is in good accordance with the description given by Lynge (1940) in most respects. The hymenium is, however, somewhat smaller than the measures mentioned by Lynge (45-55 μm compared with 60-65 (-70) μm by Lynge's type specimen).

L. pachythallina is known only from the area between c. 72-75°N in East Greenland and from the new localities in Søndre Strømfjord and Arfersiorfik Fjord in W. Greenland.

LECIDEA PAUPERCULA Th. Fr. -C.W. Greenland: Tupilak Ø, 68°42'N 52°53'W, on gneissic rock; one specimen, leg. P. Gelting, det. A.H. Magnusson. -Kronprinsens Ejlande, Imerigsoq, 69°01'N 53°19'W, 20 m, on gneissic rock; one specimen, leg. P. Gelting. -S.Disko, Godhavn, 69°15'N 53°33'W, on gneissic and basaltic rocks in scrubs, heaths and snowbeds; many specimens, leg. P. Gelting. -E. Disko, Qutdligssat, 70°05'N 53°01'W, on basaltic boulder in brook, one specimen, leg. P. Gelting.

Thallus of L. paupercula is distinctly areolate. In some plants, however, the red brown areoles are almost contiguous, while they are dispersed in others, exposing the black hypothallus. Medulla reacts I + blue. The apothecia are usually rather flat. Spores: 8-11 x 5-6 μm.

The species now appears to be common in C.W. Greenland, but is still considered rare in S.W., C.E. and S.E. Greenland (cf., e.g., Dahl, Lynge & Scholander 1937). Its distribution is circumpolar, arctic-alpine (Thomson 1979).

LECIDEA SILACEA (Ach.) Ach. -C.W. Greenland: E. Disko, Qutdligssat, 70°05'N 53°01'W, different sites, e.g., basaltic bird rock (alt. 90 m a.s.l.); three specimens, leg. P. Gelting.

The thallus of L. silacea consists of convex, rust red areoles. The hymenium and subhymenium are greenish.

The species has previously been correctly reported from Holsteinsborg somewhat farther to the south on the west coast of Greenland (Lynge 1937). It is new to C.W. Greenland, but is not known from E. Greenland. L. silacea is widely distributed in mountainous areas on the northern hemisphere.

LEMPHOLEMMA RADIATUM (Sommerf.) A. Henss. (Syn. Thyrea radiata (Sommerf.) Zahlbr.) -C.W. Greenland: Head of Søndre Strømfjord, c. 67°01'N 50°40'W, 150 m, on perpendicular irrigated siliceous rock; one specimen, leg. M. Skytte Christiansen, det. G. Degelius. - S. Disko, Godhavn, 69°15'N 53°33'W, different sites, for example temporarily moistened gneissic rock together with, e.g., Polychidium muscicola and species of Collema; three specimens, leg. P. Gelting.

All of the above specimens are sterile. They were easily identified on account of their characteristic hormocystangia occurring abundantly on the radiating lobes, some of which are more than 1 cm long (cf. also Dahl (1950). Degelius (1982) reported on some specimens of L. radiatum growing on calcareous rocks on Vega Island in Northern Norway. The species still is to be considered rare in Greenland in spite of the new localities in C.W. Greenland. It has not been found in E. Greenland so far.

OCHROLECHIA GRIMMIAE Lynge -S.W. Greenland: Kangerdluarssuk, 60°53'N 45°50'W, on Racomitrium lanuginosum (=R.l.); one specimen, leg. J. Feilberg, det. the present author. -Ivigtut, 61°12'N 48°10'W, on Racomitrium-hummock at the border of bog; one specimen, leg. P. Gelting. -C.W. Greenland: Arfersiorfik Fjord, Kuánit, 68°05'N 52°12'W, 15 m, on R.l. growing on N. -sloping gneissic rock; one specimen, leg. P. Gelting. - S. Disko, Godhavn, 69°15'N 53°33'W, several sites, on R.l., eight specimens, leg. P. Gelting; three specimens, leg. J. Poelt & H. Ullrich. - S. Disko, Fortunebay (and Kangârssuk), c. 69°16'N 53°50'W, on R.l. on, e.g., N. -sloping gneissic rocks, six specimens, leg. P. Gelting; two specimens, leg. J. Poelt & H. Ullrich. - Diskofjord, Qivitut, 69°27'N 53°38'W, 10 m, on R.l. on N. -exposed gneissic boulder; two specimens, leg. P. Gelting. -Diskofjord, Kuánit, 69°34'N 54°18'W, 40 m, Racomitrium-bog; one specimen, leg. P. Gelting. -W. Disko, Mellemfjord, Enoks havn, 69°47'N 54°55'W, 30 m, on Racomitrium-hummock near bird place; one specimen, leg. P. Gelting. -W. Disko, Qasigissat, 69°53'N 54°48'W, 20 m, on R.l., one specimen, leg. P. Gelting. -W. Disko, Nordfjord, Kugssinerssuaq, 69°55'N 54°25'W, 30 m, heath patch dominated by R.l. in stony place; two specimens, leg. P. Gelting.

This very characteristic species is circumpolar, arctic (Thomson 1979). It has previously been reported from W. Greenland by, e.g., T.W. Böcher (1954) and P. Gelting (1955). The present collections show that O. grimmiae is a common species in C.W. Greenland. It is also common further southwards on the west coast (E.S. Hansen 1978 a), while it appears to be very rare in E. Greenland with only one record from Tugtilik (66°20'N 35°00'W).

PARMELIA EXASPERATULA Nyl. -S.W. Greenland: Arsuk (Kungnait), 61°12'N 48°25'W, on rock; one specimen, leg. E. Dahl. -N. Sermilik, Tasiussaq, 61°09'N 45°45'W, on rock; one specimen, leg. E. Dahl. -C.W. Greenland: S. Disko, Godhavn, 69°15'N 53°32'W, on manured gneissic rocks together with, e.g., *Xanthoria elegans* and *Physcia dubia*; three specimens collected in different sites by P. Gelting and revised by T. Esslinger. He also revised the two specimens collected by E. Dahl. First, most of the above specimens were identified as *Parmelia infumata* Nyl. (cf. Dahl 1950). This determination is, however, wrong, as the isidia are distinctly inflated, clavate to spatulate, not cylindrical or branched as seen by P. infumata (Esslinger 1977). J. Poelt & H. Ullrich collected P. exasperatula on basaltic rocks at Godhavn. The epilithic specimens of P. exasperatula from Greenland are sterile.

All previous Greenland records of the species are from more southern localities on the west coast (Alstrup 1977, 1982), where it grows on *Salix glauca*, *Betula nana* and on imported timber. The additional specimens of P. exasperatula support the statement of Alstrup that the species must be considered native to Greenland (SW, CW). It is widely distributed in North America, Europe and Asia (Esslinger 1977).

PARMELIA SUBSTYGIA Räs. -S.W. Greenland: Tunugdliarfik, Qissungadalen, c. 61°N 46°W, on rock; one specimen, leg. E. Dahl. -Tunugdliarfik, Qordlortoq, 61°13'N 45°30'W, on rock together with *Xanthoria candelaria*; two specimens, leg. E. Dahl. -C.W, Greenland: Søndre Strømfjord, 67°01'N 50°43'W, 20-50 m, on rock in steppe-like area; one specimen, leg. J. Poelt & H. Ullrich. -Arfersiorfik Fjord, Ordlerfik, 68°07'N 50°55'W, on gneissic rocks together with *Parmelia disjuncta*; two specimens, leg. P. Gelting. -Arfersiorfik Fjord, Agpaqarfik, 68°11'N 51°46'W, 20 m, on vertical surface of rock together with *Rhizoplaca melanophthalma*; one specimen, leg. P. Gelting. -Igdluko, 68°49'N 51°11'W, on W. -exposed surface of rock together with *Phaeophyscia sciastra*; two specimens, leg. P. Gelting. -E. Greenland: Renbukta, 73°21'N 26°30'W, on gneissic rock together with *Xanthoria elegans*; one specimen, leg. B. Lynge. The above notes on the habitat of P. substygia indicate that the species in Greenland has a preference for rocks influenced by guano or dust rich in nutritive matters.

T. Esslinger has revised the above-mentioned specimens, which previously have been referred to other species of Parmelia such as *P. glomellifera* Nyl. (=*P. verruculifera* Nyl.), *P. granulosa* Lynge (=*P. disjuncta* Erichs.) and *P. isidiotyla* Nyl. (=*P. loxodes* Nyl.). P. substygia differs, however, from these species, e.g., by the characteristic C+ rose or red medullary reaction (Esslinger 1977).

P. substygia has previously been reported from a few localities in S.W. and C.E. Greenland (K. Hansen 1971, E.S. Hansen 1982). It is an addition to the lichen flora of C.W. Greenland. The new localities show that the species is widely distributed in Greenland, and that it is rather common on the west coast. Esslinger (1977) has outlined its world distribution.

PHYLLISCUM DEMANGEONII (Moug. & Mont in Mont.) Nyl. -C.W. Greenland: Arfersiorfik Fjord, Ordlerfik, 68°07'N 50°55'W, 15 m, on temporarily moistened gneissic rocks; one specimen, leg. P. Gelting. -S. Disko, Godhavn, 69°15'N 53°33'W, several sites, e.g., moist gneissic rocks together with *Umbilicaria vellea* and *Pyrenopsis* sp.; eight specimens, leg. P. Gelting; on gneissic and basaltic rocks; three specimens, leg. J. Poelt & Ullrich. -S. Disko, Lyngmarksfjeldet, 69°16'N 53°35'W, on basaltic rock; one specimen, leg. J. Poelt & H. Ullrich. -S. Disko, Fortunebay 69°16'N 53°44'W, on gneissic and basaltic rocks; two specimens, leg. J. Poelt & H. Ullrich. -Diskofjord, Kangikitleq, 69°26'N 53°30'W, on rock; one specimen, leg. P. Gelting. -W. Disko, Mellemfjord, 69°41'N 54°27'W, on rock; one specimen, leg. P. Gelting. -Nûgssuaq Peninsula, Sarqaq, 70°01'N 51°57'W, 20 m, on S. -exposed gneissic rock; one specimen, leg. P. Gelting.

The specimens agree well with the description given by Poelt (1969). A few thalli are, however, up to 1 cm broad. P. demangeonii has previously been reported from two localities in S.W. Greenland (Dahl 1950). It is an addition to the known lichen flora of C.W. Greenland. The species has a scattered occurrence in Scandinavia and the Alps (Poelt 1969).

RHIZOCARPON PUSILLUM Runem.- C.W. Greenland: S. Disko, Lyngmarksfjeldet, 69°16'N 53°35'W, on basaltic rock; one specimen, leg. J. Poelt & H. Ullrich. - Umanak, Marmorilik, 71°08'N 51°17'W, various sites growing parasitically on *Sporastatia testudinea* on, e.g., calcareous rocks and siliceous rocks rich in Fe; three specimens, leg. J. Poelt & H. Ullrich. -N. Greenland: North coast of Independence Fjord, Koralkysten, 82°15'N 29°30'W, 20 m, growing parasitically on *Sporastatia testudinea* on a stone on a gravelly coast plain; one specimen, leg. K. Holmen, det. the present author.

The species is new to the lichen flora of C.W. and N. Greenland. It has previously been reported from C.E. Greenland by the present author, who also gave some short notes on its distribution outside Greenland (E.S. Hansen 1982).

RINODINA CACUMINUM (Th. Fr.) Malme -S.W. Greenland: Nanortalik, 60°09'N 45°15'W, on gneissic rock; two specimens called "*Rinodina exigua*", leg. P. Eberlin. -C.W. Greenland:

Arfersiorfik Fjord, Itivdliarssuk, 67°55'N 50°40'W, 25 m, on gneissic bird rock; one specimen leg. P. Gelting. -S. Disko, Godhavn, 69°15'N 53°32'W, on gneissic bird rocks together with, e.g., *Lecidea atrobrunnea*, *Lecanora polytropa* and *Acarospora molybdina*; three specimens, leg. P. Gelting. -S. Disko, Søndre Laksebugt, 69°19'N 53°54'W, 20 m, on basaltic rock together with *Xanthoria candelaria* and *Physcia dubia*; one specimen, leg. P. Gelting. -Diskofjord, Eqalunguit, 69°33'N 53°36'W, on gneissic rock together with *Xanthoria candelaria* and *Physcia dubia*; one specimen, leg. P. Gelting.

All the above specimens have been determined by H. Mayrhofer. They agree well with the description given by Mayrhofer & Poelt (1979). The spores of R. cacuminum are intermediate between the *Diploecium*-type and the *Buellia*-type.

R. cacuminum is new to the lichen flora of S.W. Greenland. It has previously been reported from three localities situated between c. 73-75°N in N.E. Greenland (Lynge 1940) and one locality, Ordlerfik (68°08'N 50°55'W), in C.W. Greenland (Gelting 1956). However, the new localities reported on here indicate that R. cacuminum is a rather common species in C.W. Greenland. At Ordlerfik it was found growing on moderately manured bird rocks in association with *Umbilicaria decussata*, *Xanthoria candelaria*, *Physcia dubia*, *Dimelaena oreina* and *Rhizoplaca melanophthalma*.

R. cacuminum is distributed in Scandinavia, Franz Josef Land, North America and Greenland (Thomson 1979).

RINODINA CASTANOMELA (Nyl.) Arn. -C.W. Greenland: Disko, Qingartût (near Asuk?, 70°12'N 50°17'W, on siliceous rock together with *Xanthoria elegans* (no frothing with HCl, but the rock surface has presumedly been manured by birds); one specimen collected by P. Gelting and determined by H. Mayrhofer.

The spores of this species also belong to the *Bicincta* type, but it differs from the closely related *Rinodina calcigena* by its thallus, which is thick, areolate and slightly lobed at circumference.

R. castanomela is previously known from the Alps, Macedonia and Tatra (Mayrhofer & Poelt 1979). It is new to Greenland.

ACKNOWLEDGEMENTS

I wish to thank Helmut Mayrhofer (Graz) and Theodore Esslinger (Fargo) for revision of Greenlandic collections of Rinodina and Parmelia, respectively, and J. Sheard (Saskatoon) for additional information about Arctic Rinodinas. I also wish to thank Josef Poelt (Graz) and Hans Ullrich (Goslar) for providing me with collections from C.W. Greenland and for many discussions of Greenlandic lichens. The photographs were made by Jørgen Andersen and the present author. Ingvar Kärnefelt (Lund) read the manuscript.

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SYNNEMATOUS FUNGI FROM JAPAN. I.

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ABSTRACT

The generic definition of the genus Arthrobotryum Cesati, Hyphomycetes, Deuteromycotina, is extended, and a new species, A. hyalospora is described. A new species, Graphilbum pleomorphum is also described and its conidiogenesis is discussed.

During a survey of the synnematous fungi of Japan, new species of Arthrobotryum Cesati and Graphilbum Upadhyay & Kendrick were found. These are described and illustrated.

MATERIALS AND METHODS

The fungi described in this paper were collected on decaying bark and twigs and isolations were made with a Skerman's type micromanipulator or a sterile fine needle on Miura's medium (LCA; Miura and Kudo, 1970: glucose 1 g, KH_2PO_4 1 g, $MgSO_4 \cdot 7H_2O$ 0.2 g, KCl 0.2 g, $NaNO_3$ 2 g, yeast extract 0.2 g, agar 15 g, and 1 liter distilled water; pH not adjusted).

Isolates were grown on the following eight kinds of media at 20 C: 2% malt extract agar (MA), potato dextrose agar (PDA), cornmeal agar (CMA), and Czapek-Dox agar (CDA)— all from Nissui Pharmaceutical Co., Ltd., Tokyo, Japan; V-8 agar (V-8) and potato sucrose agar (PSA)— the formulae in Plant Pathologist's Pocketbook, CMI, Kew; LCA and one yeast decoction agar (EA; commercial brewer's dried yeast-"Ebios," 10 g, glucose 20 g, agar 15 g, and 1 liter distilled water).

Line drawings were made with an Abbe drawing apparatus and photomicrographs were taken on a Nikon XF-NT-21 Nomarski interference and phase contrast microscope, Nikon XF-21 microscope and Carl Zeiss Jena citoval stereomicroscope.

For scanning electron microscopy, fungi growing on agar plates were fixed and dehydrated (Cole and Samson, 1979). Dried specimens were submerged in distilled water, and the above mentioned treatments were subsequently carried out. After critical point drying, materials were coated within a JEOL ion sputter JFC-1100 and observed by a JEOL scanning electron microscope JSM-T20.

DESCRIPTION AND DISCUSSION

Arthrobotryum hyalospora Okada & Tubaki, sp. nov.
Figs. 1-8, 20, 21.

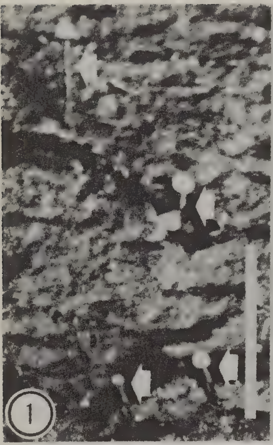
Synnemata dispersa vel interdum aggregata in turma, nonramosa, capitata, cum capitulo conidico albo subgloboso in stipe ato vel atrobrunneo, 480-1600 µm longa, 20-160 µm lata; hyphae interies stipis brunneae, septatae, ramosae, laeves; hyphae peridii stipis cum projecturis acutis secus dimidium fere superum stipis. Cellulae conidiogenae hyalinae, leviter effusae ad apicem stipis, leviter contractae apicem versus, annellatae, 22-45 x 2-3 µm. Conidia holoblastica, hyalina, 3-septata, laevia, obclavata, cum apice angusto et dente basi, recta vel leviter curva, 42.5-50 x 5-6.2 µm.

Synnemata scattered or sometimes aggregated in a group, unbranched, capitate, with a white subglobose conidial head on a black or dark brown stipe which tapers gradually toward the apex, 480-1600 µm long, 20-160 µm wide; inner hyphae forming the stipe brown, septate, branched, smooth; peripheral hyphae of the stipe with acute projections of outer wall layer of cells along nearly the upper half of the stipe. Conidiogenous cells hyaline, slightly spreading at the top of the stipe, less adherent to each other, tapering slightly toward the apex, proliferating percurrently, 22-45 x 2-3 µm. Conidia holoblastic, accumulating in a wet drop, hyaline, 3-septate, smooth, obclavate, distally narrowed to 0.8 µm and sometimes apically slightly swollen to 1 µm, with a denticle at the base, straight or slightly curved, 42.5-50 x 5-6.2 µm.

Colonies on MA, PDA, V-8, PSA, and EA waxy, white to yellowish white, becoming partly dark brown with age, concolorous in reverse. Colonies on CMA and LCA somewhat restricted, effuse, white, becoming partly dark brown or black with age, concolorous in reverse. Colonies on CDA restricted. Synnemata on PDA, CMA, V-8, PSA, LCA, and EA aggregated in a group, as on the natural substrate but variable in height, sometimes more than 3800 µm long. Conidiogenous cells and conidia as on the substrate.

Specimens examined: On decaying branches of broad-leafed tree, Yona, Kunigami-mura, Okinawa Pref., Japan, 29 March 1983 (TKBF-5084; HOLOTYPE, and TKBF-5085; ISOTYPE). The type and paratype specimens are deposited in the herbarium of the University of Tsukuba. The culture is preserved in the Institute of Biological Sciences, the University of Tsukuba, as TKBC-1367, and the Institute for

Figs. 1-8. *Arthrobotryum hyalospora*. 1. Synnemata on the substrate (arrows); scale, 2 mm. 2. Synnema, from the substrate; scale, 500 µm. 3. Synnemata in culture, SEM; scale, 1 mm. 4. Upper part of a synnema with hyphal projections, from the substrate, SEM; scale, 100 µm. 5. Synnema with hyphal projections, in culture, SEM; scale, 50 µm. 6. Percurrently proliferating conidiogenous cells, in culture, SEM; scale, 20 µm. 7. Conidia in culture, SEM; scale, 20 µm. 8. Conidia from the substrate, Nomarski interference; scale, 40 µm.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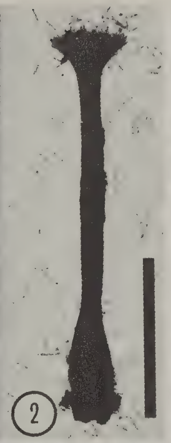
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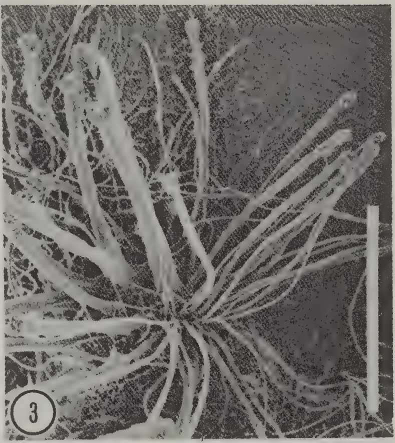
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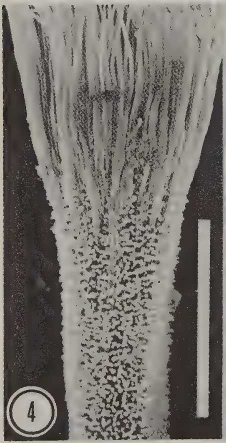
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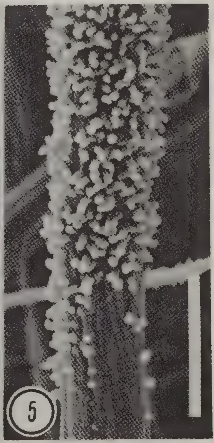
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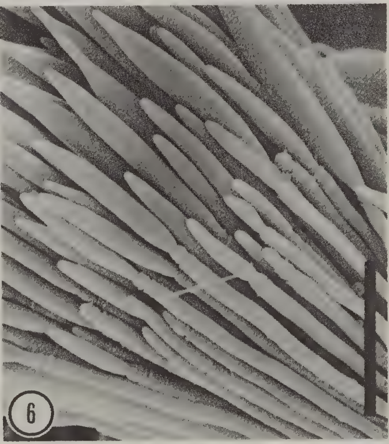
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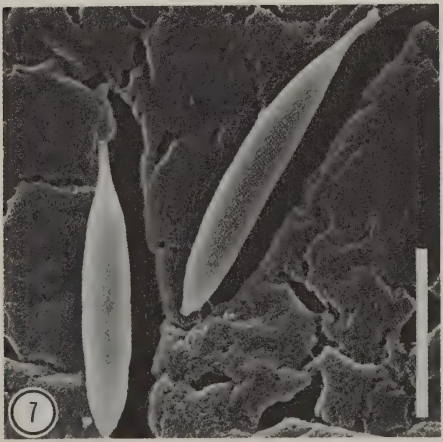
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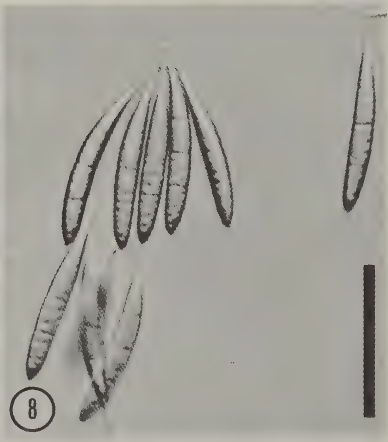
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Fermentation, Osaka, as IFO 31611.

The genus *Arthrobotryum* was established by Cesati in 1854 for the single species *A. stilboideum* Ces., which was redescribed by Hughes (1951).

Arthrobotryum stilboideum has very pale brown phragmoconidia developing holoblastically from annellides and accumulating in a slimy head (Hughes, 1951; Morris, 1963; Ellis, 1971; Hawksworth et al., 1983). Barnett and Hunter (1972) and Carmichael et al. (1980), however, mentioned that conidia of *Arthrobotryum* are hyaline to dark. *Arthrobotryum atrocephalum* (Ellis) Sacc. has pale straw-colored conidia (Ellis, 1976). The present fungus has hyaline, transversely 3-septate conidia (Figs. 7, 8, 20).

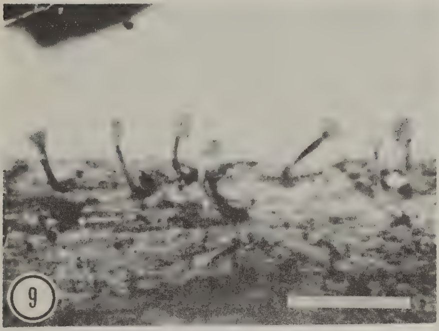
Synnemata of *Arthrobotryum* have previously been characterized as smooth, with no ornamented or verrucose cells on the stipe of the synnema. Some genera, e.g., *Phialographium* Upadhyay & Kendrick, *Myrothecium* Tode ex Fries etc., include species provided with or without ornamented cells (Rao & Sutton, 1975; Ellis, 1971 & 1976; Tulloch, 1972). In this paper, we have not stressed the character of ornamented cells protruding from the hyphae of the conidiomata as a taxonomic criterion.

As for allied fungi, *A. hyalospora* seems to be more closely ralated to *A. atrocephalum* than to *A. stilboideum* on the basis of the conidial morphology. However, *A. hyalospora* is distinguished from *A. atrocephalum* by the coloration of stipe, conidial head and conidia, and the possession of ornamented cells of the stipe hyphae. *Morrisographium persicae* (Schw.) Illman & White, the type species of *Morrisographium* Morelet, and *A. hyalospora* also superficially resemble each other fairly well (Morris, 1966; Morelet, 1968; Illman and White, 1984). The conidiogenesis of *M. persicae* remains uncertain at present (Carmichael et al., 1980). Ornamented cells of the stipe hyphae are observed in *M. persicae* (personal communication from Dr. S. J. Hughes). Comparative study of the conidiogenesis and other characteristics are required in *A. hyalospora* and *M. persicae*.

Graphilbum pleomorphum Okada & Tubaki, sp. nov.

Figs. 9-19, 22-27.

Figs. 9-19. *Graphilbum pleomorphum*. 9. Synnemata on the substrate; scale, 2 mm. 10. Synnema, from the substrate; scale, 500 µm. 11. Synnema, in culture, SEM, scale, 200 µm. 12. Percurrently proliferating conidiogenous cells, from the substrate, phase contrast; scale, 10 µm. 13. Percurrently proliferating conidiogenous cells, from the substrate, SEM; scale, 10 µm. 14, 15. Sympodially (large arrows) and percurrently (small arrow) proliferating conidiogenous cells, from the substrate, phase contrast; scales, 10 µm. 16. Sympodially proliferating conidiogenous cell, from the substrate (arrow), SEM; scale, 5 µm. 17. Conidia, and percurrently (small arrow) and intermediately (large arrows) proliferating conidiogeneous cells, in culture, SEM; scale, 5 µm. 18. Conidia from the substrate, phase contrast; scale, 10 µm. 19. Conidia from the substrate, SEM; scale, 2 µm.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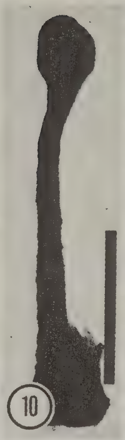
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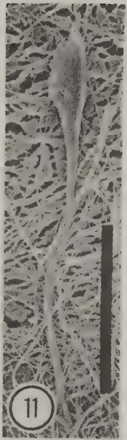
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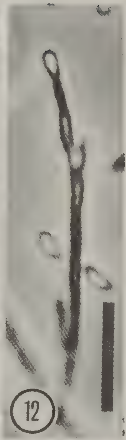
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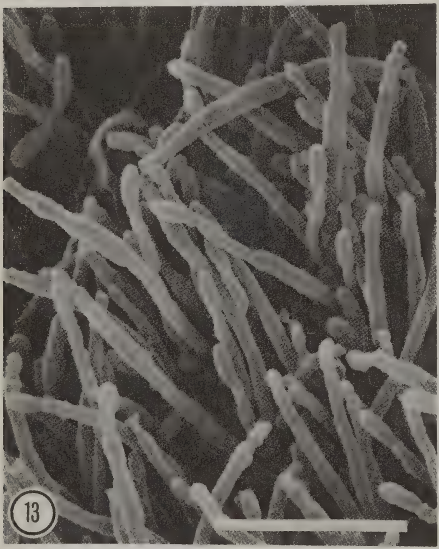
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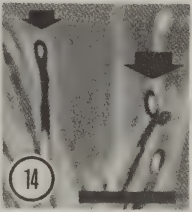
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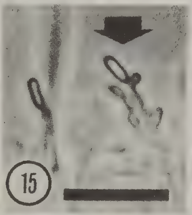
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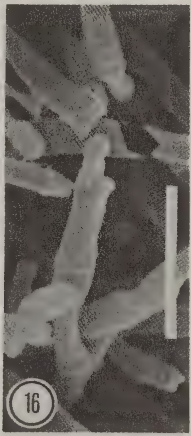
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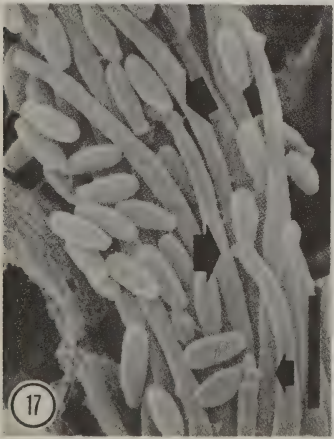
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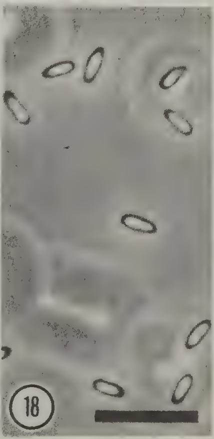
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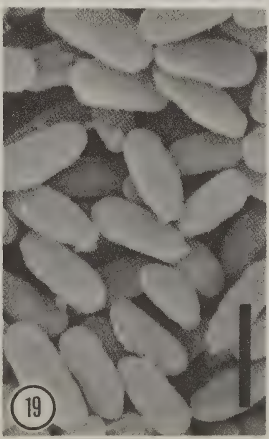
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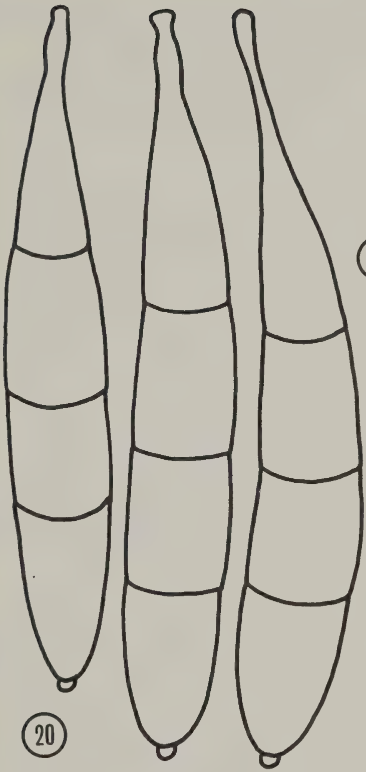
Synnemata aurantiaca brunneola, aurantiaca, vel lutea diluta, atrobrunnea interdum basi, dilutius apicem versus, erecta, dispersa, nonramosa, capitata vel spathulata, constantia ex gutta conidico globoso in stipe cylindrico, (160)400-2600 µm longa, 30-200 µm lata. Cellulae conidiogenae hyalinae, aggregatae ad apicem synnematis, annellatae ordinate, sympodiales raro, cum lateriramis brevibus, 6-17 x 1.1-1.3 µm in cellula apicale. Conidia holoblastica, hyalina, unicellularia, laevia, obovata vel elliptica oblonga, cum base angusta et aliquantum truncata, 2.8-5 x 1-1.8 µm.

Synnemata brownish orange, orange, or light yellow, sometimes dark brown at the base, becoming paler toward the apex, erect, scattered, unbranched, capitate or spathulate, consisting of a globose conidial drop on a cylindrical stipe, (160)400-2600 µm long, 30-200 µm wide. Conidiogenous cells hyaline, in groups at apex of synnematous hyphae, proliferating percurrently regularly, rarely proliferating sympodially, with short side branches, 6-17 x 1.1-1.3 µm in apical cell. Conidia holoblastic, accumulating in a yellowish white slimy head, hyaline, 1-celled, smooth, obovate to oblong-elliptical, with a narrow and somewhat truncate base, 2.8-5 x 1-1.8 µm.

Colonies on MA, PDA, V-8, PSA, and EA cottony, aerial mycelium abundant, white, concolorous in reverse. Colonies on CMA and LCA spreading, without aerial mycelium, with abundant conidia on CMA, white to colorless, concolorous in reverse. Colonies on CDA restricted. Synnemata rarely produced after more than a month of incubation, hyaline to pale yellow, capitate or spathulate, bearing a slimy drop of conidia apically, ca. 300-1100 µm long, ca. 7-90 µm wide. Mononematous conidiophores abundant, hyaline, micronematous. Conidiogenous cells of synnematous conidiophores basically same as on the natural substrate, sometimes intermediate among annellide, sympodula and a kind of phialide; conidiogenous cells of mononematous conidiophores hyaline, proliferating sympodially. Conidia of synnematous conidiophores as on the natural substrate, 2.8-3.8 x 1-1.4 µm; conidia of mononematous conidiophores holoblastic, acropetal, delimited by wide transverse septa, with the secession schizolytic to make slimy drops, obovate, cylindrical or elliptical with truncate base, variable in size, 3-13 x 1.2-2 µm.

Figs. 20-27. Conidia, conidiogenous cells and ornamented cells of the species of Arthrobotryum and Graphilbum. 20. Anneloconidia of *A. hyalospora*, from the substrate. 21. Projections of outer wall layer of cells of the stipe hyphae of *A. hyalospora*, from the substrate. 22. Conidia of *G. pleomorphum*, from the substrate. 23. Conidia of synnematous conidiophores of *G. pleomorphum*, in culture. 24. Conidia of mononematous conidiophores of *G. pleomorphum*, in culture. 25. Percurrently proliferating conidiogenous cells of *G. pleomorphum*, from the substrate. 26. Sympodially proliferating conidiogenous cells of *G. pleomorphum*, from the substrate. 27. Sympodially proliferating conidiogenous cells on mononematous conidiophores, and conidia of *G. pleomorphum*, in culture. Scale in Fig. 27 represents 10 µm for all figures.



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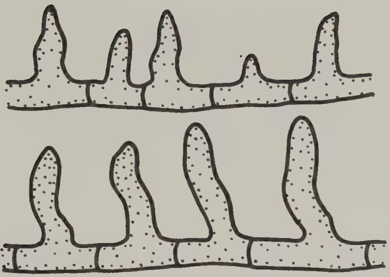

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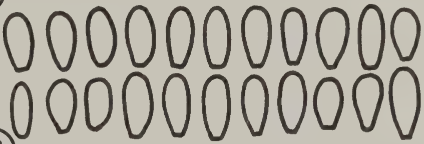

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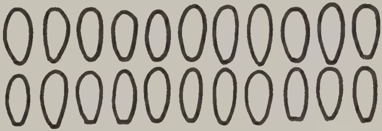

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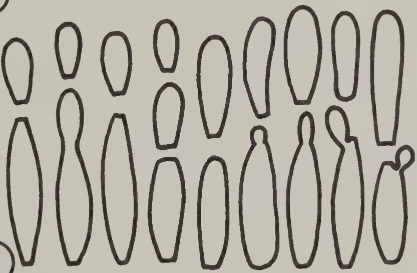

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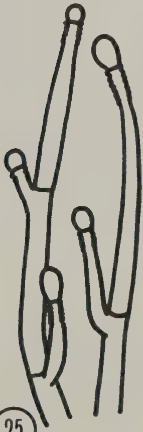

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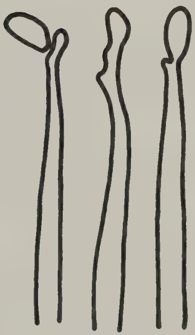

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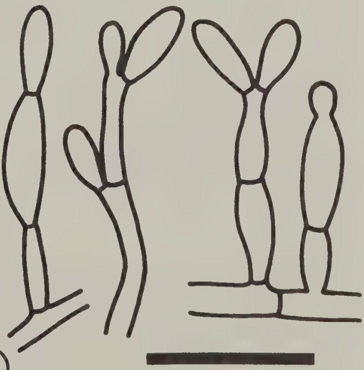

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Specimens examined: On decaying branches, 23rd river, Teshio-cho, Teshio-gun, Hokkaido, Japan, 30 Nov. 1983 (TKBF-5087; HOLOTYPE, and TKBF-5088; PARATYPE). The type and paratype specimens are deposited in the herbarium of the University of Tsukuba. The cultures are preserved in the Institute of Biological Sciences, the University of Tsukuba, as TKBC-1369, and 1370, and the Institute for Fermentation, Osaka, as IFO 31613, and 31614.

Upadhyay and Kendrick (1975) established the monotypic genera *Graphilbum* and *Hyalopesotum*. *Stilbella* Lindau and the above two genera are distinguished by their conidiogenesis: i.e., *Stilbella* (phialidic), *Graphilbum* (annellidic), *Hyalopesotum* (sympodial). The same situation is also found among the three genera, *Graphium* Corda (annellidic), *Pesotum* Crane & Schoknecht (sympodial), and *Phialographium* Upadhyay & Kendrick (phialidic).

Graphilbum pleomorphum has taller synnemata than *G. sparsum*, the type species of the genus, on natural substrates (Figs. 9, 10), and they are sometimes dark brown at the base. Conidiogenous cells of synnemata rarely proliferate sympodially as well as percurrently in nature and culture (Figs. 12-17, 25, 26). Some aberrant conidiogenous cells observed in culture (Fig. 17) are intermediate between annellide, sympodula and a kind of phialide (i.e., the phialides of some species of *Chloridium* Link ex Fr., *Cacumisporium* Preuss and *Codinaea* Maire) as stated by Cole and Samson (1979). Holoblastic conidia are also abunduntly produced in culture on mononematous conidiophores (Figs. 24, 27). These plasticities are examples of the intergradation between annellidic, sympodial and blastic conidiogenesis, as mentioned by Minter et al. (1982), Zhang et al. (1983) and Tsuneda and Hiratsuka (in prep. for publ.). In this pleomorphic fungus, the Botanico-anatomical system was used and the annellidic condition was considered to be the typical state.

The occasional dark brown color at the base of very tall synnemata of *G. pleomorphum* might suggest close relation to *Graphium* Corda. *Graphium penicillioides* Corda also shows occasional sympodial holoblastic conidiogenous cells (Sutton, 1973). In culture, however, colonies and synnemata of *G. pleomorphum* are hyaline to white and hyaline to pale yellow respectively. On the substrate, the synnemata of *G. pleomorphum* are much paler than those of *Graphium*.

ACKNOWLEDGMENTS

We thank Mr. T. Aoki for collecting material in Hokkaido and Dr. N. Nakamura who helped to make the collecting in Okinawa convenient. We are also indebted to Drs. S. J. Hughes and R. P. Korf for reviewing the manuscript.

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NEW NAMES, NEW COMBINATIONS AND NEW SYNONYMY IN THE CORTICIACEAE, HYMENOCHAETACEAE AND POLYPORACEAE

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SUMMARY

Forty-three new combinations are proposed in *Antrodia, Ceriporiopsis, Ceriporia, Cerocorticium, Flaviporus, Hyphoderma, Junghuhnia, Phlebia, Piloporia, Poria, Skeletocutis, Spongipellis* or *Wolfiporia.* The new names *Phellinus overholtsii* and *Poria berkeleyi* are proposed.

My studies of the North American polypores and recent taxonomic papers by colleagues have revealed that a number of species are generically misplaced or that the species epithets have not been formally assigned to the correct genera. In an effort to align congeneric species several new combinations and new names are proposed. Based on the study of the type specimens, two names are placed in synonymy.

Antrodia Karst.: Polypores with skeletal hyphae, generative hyphae with clamps, white to tan context, smooth, nonamyloid spores and associated with a brown rot have been placed in *Antrodia.* One other North American species, currently misplaced in *Poria,* has these features and is transferred to *Antrodia.*

Antrodia oleracea (Davids. et Lombard) Ginns, c. nov.
Basionym: *Poria oleracea* Davidson et Lombard, Mycologia 39: 317. 1947. A detailed description appeared in Lowe (1966: 99).

Ceriporiopsis Domanski: This genus contains three species formerly placed in *Poria* s.l. One other species from North America, *P. subrufa* has the features typical of *Ceriporiopsis* and is transferred to it.

Ceriporiopsis subrufa (Ellis et Dearn.) Ginns, c. nov.
Basionym: *Poria subrufa* Ellis et Dearn., Roy. Canadian Inst. Proc., N.S., 1: 89. 1897. The portion of the type specimen in Dearness Collection (DAOM) was studied. A detailed description appeared in Lowe (1966: 66).

Ceriporia Donk: Several species with simple-septate hyphae, small cylindrical to allantoid spores and the cupulate type of hymenial development have been segregated from *Poria* s.l. under the name *Ceriporia*. One other species is transferred to the genus.

Ceriporia tarda (Berk.) Ginns, c. nov.
Basionym: *Polyporus tardus* Berk., Lond. J. Bot. 4: 56. 1845. A detailed description appeared in Lowe (1966: 32).

Cerocorticium Henn.: *Corticium cremoricolor* is misplaced in *Corticium*. The species is congeneric with *Cerocorticium confluens* (Fr.:Fr.) Jül. et Stalpers and is transferred to *Cerocorticium*.

Cerocorticium cremoricolor (Berk. et Curt.) Ginns, c. nov.
Basionym: *Corticium cremoricolor* Berk. et Curt., Grevillea 1: 180. 1873.

Flaviporus Murr.: A taxonomic synonym is *Antrodiella* Ryv. and several transfers of species formerly placed in *Antrodiella* are made.

Flaviporus americanus (Ryv. et Gilbn.) Ginns, c. nov.
Basionym: *Antrodiella americana* Ryv. et Gilbn., Mycotaxon 19: 138. 1984.

Flaviporus citrinellus (Niemelä et Ryv.) Ginns, c. nov.
Basionym: *Antrodiella citrinella* Niemelä et Ryv., Karstenia 23: 26. 1983.

Flaviporus hoehnelii (Bres.) Ginns, c. nov.
Basionym: *Polyporus hoehnelii* Bres. in Höhnel, Sitzungsber. Kaiserl. Akad. Wiss. Wien (Math.-nat. Kl., Abt. 1) 121: 344. 1912. Placed in *Antrodiella* by Niemelä (1982).

Flaviporus hunuus (Cunn.) Ginns, c. nov.
Basionym: *Poria hunua* Cunn., N.Z. Dep. Sci. Ind. Res. Bull. 72: 19. 1947. Placed in *Antrodiella* by Ryvarden and Johansen (1980).

Flaviporus onychoides (Egeland) Ginns, c. nov.
Basionym: *Polyporus onychoides* Egeland, Nyt Mag. Naturvidenskaberne 51: 92. 1913. Placed in *Antrodiella* by Niemelä (1982).

Flaviporus overholtsii (Ryv. et Gilbn.) Ginns, c. nov.
Basionym: *Antrodiella overholtsii* Ryv. et Gilbn., Mycotaxon 19: 139. 1984.

Flaviporus romellii (Donk) Ginns, c. nov.
Basionym: *Poria romellii* Donk, Persoonia 5: 84. 1967. Placed in *Antrodiella* by Niemelä (1982).

Flaviporus semisupinus (Berk. et Curt.) Ginns, c. nov.
Basionym: *Polyporus semisupinus* Berk. et Curt., Grevillea 1: 50. 1872. Placed in *Antrodiella* by Ryvarden and Johansen (1980).

Flaviporus stramineus (Bres.) Ginns, c. nov.
Basionym: *Poria straminea* Bres., Hedwigia 51: 316. 1912. Placed in *Antrodiella* by Ryvarden and Johansen (1980).

Hyphoderma Wallr. em Donk: *Peniophora insusitata* has the typical features of *Hyphoderma*. This fungus was described at a time when any corticioid basidiomycete with cystidia was almost automatically placed in *Peniophora*. The current circumscription of *Peniophora* excludes *P. insusitata*, therefore, the name is transferred to *Hyphoderma*. *Hyphoderma litschaueri* (Burt) Erikss. et Strid is similar in many respects but differs in having significantly larger spores.

Hyphoderma insusitata (Jacks. et Deard.) Ginns, c. nov.
Basionym: *Peniophora insusitata* Jackson et Dearden, Can. J. Res., C, 27: 150. 1949.

Junghuhnia Corda em. Ryv.: *Poria radula* Pers. is considered a synonym of *Schizopora paradoxa* (Fr.) Donk (1974: 171). However, *P. radula* sensu Bresadola (1916) has, according to specimens in DAOM and Lowe's (1966: 114) description, the typical features of the genus *Junghuhnia*. The only applicable name for the fungus described by Bresadola and Lowe is *P. eupora* var. *subfimbriata* Romell which is hereby raised to the species level and transferred to *Junghuhnia*.

Junghuhnia subfimbriata (Rom.) Ginns, stat. nov. & c. nov.
Basionym: *Poria eupora* var. *subfimbriata* Rom., Svensk Bot. Tidskr. 20: 16. 1926.

Phellinus overholtsii Ginns, sp. nov.
Fomes occidentalis Overholts, Mycologia 33: 101. 1941 (nom. invalid., Art. 36, no Latin description).
Fomes occidentalis "L.O. Overholts, sp. nov." Mycopath. Mycol. appl. 46: 352. 1972 (nom. invalid., Art. 34.4, proposed simultaneously with *Phellinus occidentalis*, thus neither is validly published).
Phellinus occidentalis "(Overh.) Gilbertson, comb. nov." Mycopath. Mycol. appl. 46: 352. 1972 (nom. invalid., Art. 34.4, see preceding explanation).

Latin description given on page 352 of Lombard et al. (1972) under the name *Fomes occidentalis*. Type specimen is here designated as: J.R. Weir 7994, on *Crategus douglasii* Lindl., USA: Idaho: Coeur d'Alene (BPI). The specimen proposed as type by Lombard et al. (1972) is not used because it is a mixture of two collections (cf. Lombard et al. 1972: 352) and may be composed of more than one taxon. The name *F. occidentalis* first appeared in Overholts (1941) but was not validly published because a Latin description was not included.

Lombard et al. (1972) intended to validly publish the name, cited the authority as "L.O. Overholts", but immediately proceeded to propose a new combination as "*Phellinus occidentalis* (Overh.) Gilbertson".

The new species name proposed by Lombard et al. (1972) may be correctly cited as *Fomes occidentalis* Lombard, Davids. et Gilbn. (Art. 46, rec. C.1). Although the 1978 edition of the International Code of Botanical Nomenclature provides the option for citing the authority as "Overholts ex Lombard, Davids. et Gilbn." this is not necessary. Similarly the proposed combination may be correctly cited as *Phellinus occidentalis* (Lombard, Davids. et Gilbn.) Lombard, Davids. et Gilbn. (Art. 46, rec. C.1). However, it is clear that because the same authors have simultaneously proposed alternative names neither is validly published (Art. 34.4). Ryvarden and Gilbertson (1984: 142) argue that the name *Fomes occidentalis* and the combination in *Phellinus* were validly published in Lombard et al. (1972), because, according to their (R. & G.) interpretation, the validation of the name and the new combination were made by different authors. If this view is accepted, then additional combinations in the same paper in other genera by various permutations of the three author's names, Lombard, Davidson and Gilbertson, would have to be acceptable. The fact that Gilbertson alone claimed responsibility for the combination, "(Overh.) Gilbertson", does not, in this case, allow him to be considered as an author publishing in another author's work as treated in Art. 46, rec. D.1. To be an author of the article and then to claim to be one author publishing in another author's work is unacceptable.

In addition to coining two names Lombard et al. (1972) proceeded to use the name *Phellinus occidentalis* throughout their paper rejecting the *Fomes* combination. Obviously they were of the opinion that the fungus was a *Phellinus* before they proposed the name in *Fomes* thus their rejection of the name (cf. Art. 34.1) *F. occidentalis* indicated that it was a superfluous name.

Additional descriptions of basidiomes can be found under the name "*Fomes occidentalis*" in Overholts (1953: 66), Lowe (1957: 48) and Gilbertson (1979: 70).

Phlebia Fr.: The current circumscription of this genus includes corticioid species with ceraceous basidiomes, hyaline, smooth, thin-walled, nonamyloid, rather narrow spores, thickening subhymenial development, clamp connections, and narrowly clavate basidia. The following species, misplaced in *Peniophora,* is transferred to *Phlebia*.

Phlebia unica (Jacks. et Deard.) Ginns, c. nov.
Basionym: *Peniophora unica* Jackson et Dearden, Can. J. Res., C, 27: 148. 1949. *Phlebia unica* is similar to and should be critically compared to *P. cremeo-alutacea* (Parm.) Larss. et Hjort.

Phlebia erecta Rea, British Basidiomycetes, p. 625. Cambridge Univ. Press, London. 1922. After study of the type specimen (Herb. Carleton Rea, North of the Paradise, Grimscote Downs, Witchurch, Warwickshire, 25.X.1915, (on burnt soil and woody debris, among mosses-J.G.), at K, here designated lectotype) the name *P. erecta* is placed in synonymy with *P. rufa* (Fr.) M.P. Chr.

Piloporia Niemelä (1982a): This monotypic genus was proposed for *P. sajanensis* (Parm.) Niemelä, however, one other species has the features of that genus.

Piloporia albobrunnea (Rom.) Ginns, c. nov.
Basionym: *Polyporus albobrunneus* Rom., Arkiv. f. Bot. 11(3): 10. 1912.

Poria ferox Long. et Baxter, Mich. Acad. Sci., Arts, Lett., Papers 25: 149. 1940. After study of the type specimen (USA: Arkansas: Ozark Nat. For.: Casteel, 28 Aug. 1912, W.H. Long, FP 12150 at BPI) the name *P. ferox* is placed in synonymy with *Antrodia serialis* (Fr.) Donk. Lowe (1958) suggested that *P. ferox* "may be a form of" *A. serialis*. The size and shape of the spores previously reported for *P. ferox* have varied. The original description simply stated "spores hyaline, 5-6 x 3µ". Lowe (1958) reported "Very few and not wholly certain spores seen on the type and all other material of this [fungus] studied". The most detailed description of the spores of *P. ferox* appeared in Lowe (1966) where the shape and size was given as "somewhat fusoid or shaped like an apple seed, 6.5-8 x 2.5-3µ". Lowe's (1966) figure 75 of spores from the type specimen shows a shape close to but significantly distinct from the spores I saw on the type (Fig. 1). The spores I measured were 7.4-8.4 x (2.8-)3.2µm.

Poria Pers. 1794. Section *Poria*. Lectotype: *Boletus medulla-panis* Jacq.:Fr. (see Donk, 1960: 266-270; 1967: 50-67; 1974: 150). Section *Poria* is essentially equivalent to *Perenniporia* Murr. and

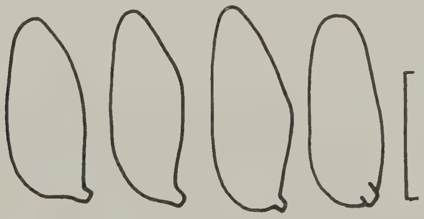

Fig. 1. *Poria ferox*. Basidiospores from FP 12150, type. Scale = 5µm.

some authors (e.g., Domanski 1972, Ryvarden 1978), following Donk's suggestion, have used *Perenniporia.* Their purpose was to group together congeneric species without having the species associations disappear in the large artificial genus that *Poria* had become. Unless *Perenniporia* is conserved, the name *Poria* has priority and combinations in *Perenniporia* are not correct. Boidin and Lanquetin (1983) and Jülich (1983) have discussed a parallel situation where *Laeticorticium* Donk was proposed to allow the segregation of several congeneric species from the heterogeneous *Corticium* Pers. These authors adopt the older name *Corticium.* The artificial nature of *Poria* can be dealt with by "*Poria,* section *Poria*" or "*Poria* sensu stricto". Thus several names previously placed in *Perenniporia* are transferred to *Poria.*

Poria ahmadii (Ryv.) Ginns, c. nov.
Basionym: *Perenniporia ahmadii* Ryv., Mycotaxon 17: 519. 1983.

Poria albida (Rajch. et Wright) Ginns, c. nov.
Basionym: *Perenniporia albida* Rajch. et Wright, Mycotaxon 15: 307. 1982.

Poria amylohypha (Ryv. et Gilbn.) Ginns, c. nov.
Basionym: *Perenniporia amylohypha* Ryv. et Gilbn., Mycotaxon 19: 140. 1984.

Poria berkeleyi Ginns, nom. nov.
Basionym: *Trametes ohiensis* Berk., Grevellia 1: 66. 1872. Placed in *Perenniporia* by Ryvarden (1972). The combination in *Poria* is preempted by *P. ohiensis* (Murr.) Sacc. et Trott. thus a new name is proposed. I am not aware of any other names, i.e. synonyms of *T. ohiensis*, that would have priority over *P. berkeleyi.*

Poria clelandii (Lloyd) Ginns, c. nov.
Basionym: *Fomes clelandii* Lloyd, Mycol. Writ. 4, Letter 60: 11. 1915. Placed in *Perenniporia* by Ryvarden (1972).

Poria compacta (Overh.) Ginns, c. nov.
Basionym: *Polyporus compactus* Overh., Bull. Torrey Bot. Club 49: 170. 1929. Placed in *Perenniporia* by Ryvarden and Gilbertson (1984).

Poria contraria (Berk. et Curt.) Ginns, c. nov.
Basionym: *Fomes contrarius* Berk. et Curt., Grevillea 15: 21. 1886. Placed in *Perenniporia* by Ryvarden (1972a).

Poria detrita (Berk.) Ginns, c. nov.
Basionym: *Polyporus detritus* Berk., Hook. J. Bot. 8: 197. 1856. Placed in *Perenniporia* by Ryvarden and Johansen (1980). Bresadola (1916) has suggested that *P. detrita* is synonymous with *Poria ochroleuca* (Berk.) Kot. et Pouz.

Poria ellipsospora (Ryv. et Gilbn.) Ginns, c. nov.
Basionym: *Perenniporia ellipsospora* Ryv. et Gilbn., Mycotaxon 19: 140. 1984.

Poria ellisiana (And.) Ginns, c. nov.
Basionym: *Fomes ellsianus* Anderson, Bot. Gaz. 16: 113. 1891. This North American species is misplaced in *Fomes* and it has the features typical of *Poria*, section *Poria*.

Poria fraxinea (Bull.:Fr.) Ginns, c. nov.
Basionym: *Boletus fraxineus* Bull., Herb. France 2, pl. 433, fig. 2. 1789. *Polyporus fraxineus* (Bull.:Fr.) Fr., Syst. Mycol. 1: 374. 1821. Placed in *Perenniporia* by Ryvarden in Ryvarden and Calonge (1976).

Poria glaucopora (Lloyd) Ginns, c. nov.
Basionym: *Fomes glaucoporus* Lloyd, Mycol. Writ. 4: 251. 1915. Placed in *Perenniporia* by Ryvarden (1972a).

Poria gomezii (Rajch. et Wright) Ginns, c. nov.
Basionym: *Perenniporia gomezii* Rajch. et Wright, Mycotaxon 15: 306. 1982.

Poria inflexibilis (Berk.) Ginns, c. nov.
Basionym: *Polyporus inflexibilis* Berk., Hook. J. Bot. 8: 199. 1856. Placed in *Perenniporia* by Ryvarden (1972a).

Poria martius (Berk.) Ginns, c. nov.
Basionym: *Polyporus martius* Berk., Hook. J. Bot. 8: 198. 1856. Placed in *Perenniporia* by Ryvarden (1972).

Poria mesoleuca (Petch) Ginns, c. nov.
Basionym: *Fomes mesoleucus* Petch, Ann. Roy. Bot. Gard. Perad. 9: 315. 1925. Placed in *Perenniporia* by Ryvarden (1972a).

Poria minutula (Henn.) Ginns, c. nov.
Basionym: *Fomes minutulus* Henn., Engl. Bot. Jahrb. 22: 88. 1895. Placed in *Perenniporia* by Ryvarden (1972a).

Poria mundula (Wakef.) Ginns, c. nov.
Basionym: *Fomes mundulus* Wakef., Forhand. Kgl. N. Vidensk. Selsk. IX: 44. 1936. Placed in *Perenniporia* by Ryvarden (1972a).

Poria phloiophila (Gilbn. et Blackw.) Ginns, c. nov.
Basionym: *Perenniporia phloiophila* Gilbn. et M. Blackwell, Mycotaxon 20: 85. 1984.

Poria robiniophila (Murr.) Ginns, c. nov.
Basionym: *Trametes robiniophila* Murr., North Amer. Fl. 9: 42. 1907. Placed in *Perenniporia* by Ryvarden (1983).

Poria rosmarini (David et Malençon) Ginns, c. nov.
Basionym: *Perenniporia rosmarini* David et Malençon, Bull. Soc. Mycol. France 94: 407. 1978(1979).

Poria truncata (Lloyd) Ginns, c. nov.
Basionym: *Trametes truncata* Lloyd, Mycol. Writ. 7: 1156. 1922. Placed in *Perenniporia* by Ryvarden (1972a).

Poria variegata (Ryv. et Gilbn.) Ginns, c. nov.
Basionym: *Perenniporia variegata* Ryv. et Gilbn., Mycotaxon 19: 140. 1984.

Skeletocutis Kot. et Pouz.: Most of the species in this genus have been segregated from *Poria* s.l. The North American fungus *Poria odora* (Peck) Sacc., as described by Lowe (1966: 90), has the typical features of *Skeletocutis* and is transferred to that genus.

Skeletocutis odora (Peck) Ginns, c. nov.
Basionym: *Polyporus odorus* Peck. N.Y. State Mus., Ann. Rept. 38: 92. 1885.

Spongipellis Pat.: The type species for this genus is *Polyporus spumeus* (Sow.:Fr.) Fr. *Polyporus spumeus* var. *malicola* although similar differs sufficiently to be recognized at the species level.

Spongipellis malicola (Lloyd) Ginns, stat. nov. & c. nov.
Basionym: *Polyporus spumeus* var. *malicola* Lloyd, Myc. Writ. 4, Apus p. 305. 1915.

Wolfiporia Ryv. et Gilbn. (1984): A monotypic genus proposed for *Poria cocos* Wolf. However, Ginns and Lowe (1983) showed *P. cocos* to be a synonym of the earlier named *Daedalea extensa* Peck. Ginns and Lowe, following the concept of *Macrohyporia* first proposed by Johansen and Ryvarden (1979), transferred *D. extensa* to that genus. Ryvarden has reconsidered its limits and excludes *P. cocos* from *Macrohyporia*.

Wolfiporia extensa (Peck) Ginns, c. nov.
Basionym: *Daedalea extensa* Peck, N.Y. State Mus., Ann. Rept. 44: 21. 1891. The species was recently treated in detail by Ginns and Lowe (1983).

Wolfiporia sulphurea (Burt) Ginns, c. nov.
Basionym: *Merulius sulphureus* Burt, Ann. Mo. Bot. Gard. 4: 333. 1971. The species is congeneric with *Wolfiporia extensa* thus the transfer of *M. sulphureus* to *Wolfiporia* is needed (see discussion in Ginns and Lowe 1983).

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COMPATIBILITY BETWEEN SPECIES OF CORTICIACEAE S.L. (BASIDIOMYCETES) FROM EUROPE AND NORTH AMERICA.

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ABSTRACT. Intercompatibility tests were made between cultures from North America and Europe for more than 40 corticiaceous species. For most species tested, the specimens from North America were compatible with the specimens from Europe. However, several tests were incompatible and especial study was made of the differences between their respective fruitbodies.

Culture characters are given for 11 species, species concepts are discussed, and a list of hitherto made crossings between specimens of corticiaceous fungi from the two continents are given.

INTRODUCTION.

The floras of corticiaceous fungi in N. America and Europe are similar in many respects. Specimens from both continents which morphologically appear identical have in most cases (but not always) been given the same name.

However, a species concept based on morphological criteria alone is sometimes insufficient, especially when relatively few characters exist, as in the corticioid fungi. To investigate the genetical basis of these morphological criteria, compatibility tests were made between specimens representing a number of species from each continent.

For most of the tested species compatibility (i.e. conspecificity) has been demonstrated between specimens from Canada and a few specimens from USA, and Europe. In these cases the species concept based on morphology has been accepted.

For a few species partial compatibility was recorded and several cultures were incompatible although the specimens from a morphological point of view, were considered to be conspecific.

Further, it cannot be taken for granted that populations of one and the same species, which are geographically well separated, should agree totally in their morphology. Therefore, special attention has been paid to description of the pertaining fruitbodies. The material used is, however, limited and the noted differences in morphology must be

interpreted with wariness.
Culture characters are given for a number of species. Some of these species have been investigated before. However, studies of different cultures help to establish the range of variation in the species.
The paper concludes with a list of the species which other compatibility tests have shown to be present on different continents.

This study is a part of the flora-project "Corticiaceae of North Europe" and for most of the species treated here, references are given to the flora, concerning morphology etc. Most of the cultures used were collected and isolated by the author or other members of the mycological research group in Göteborg during the last 3 - 4 years.

METHODS.

To test the compatibility between two single-spore-(SS)-cultures, a small piece of each culture was inoculated about 1 cm apart on a malt agar plate. After the mycelia had been in contact for four weeks or more, they were examined to determine the presence of clamp connections.
To determine the breeding ability (i.e., the ability to form clamps in matings) of the individual SS-cultures, matings between SS-cultures of each specimen were first made. Compatible mating types from one specimen were mated with compatible mating types from the other specimen.
In several cultures it was not possible to obtain compatible mating types. However, such SS-cultures have been accepted if they were compatible in matings with cultures from other specimens.

Polyspore-(PS)-cultures with clamped hyphae representing some specimens were used in di-mon matings. In this type of crossing, a piece of a PS-mycelium is inoculated at the edge of a malt agar plate, while pieces of haploid mycelia are inoculated in a half-circle around the PS-culture. After being in contact for four weeks or more the mycelium on the outside of the half-circle is checked for the occurrence of clamps (Buller's phenomenon).
In the intercompatibility pairings usually two SS-cultures from each specimen have been used. Sometimes one or more mating types, of any particular culture, were missing. The disadvantage is that some cases of partial compatibility may not have been detected.
A lot of matings were repeated, i.e. when unexpected results appeared, especially partial compatibility.

Drop tests for extra-cellular oxidases follow Marr's directions (1979); culture codes are from Nobles (1965) with emendations by Boidin and Lanquetin (1983). Neohaploidizations have been made by culturing clamped mycelia on different concentrations of ox-gall in agar. The plates with a concentration where no clamps are visible have then been homogenized in a "Ultra Turrax" homogenizator. After dispersal, haploid cultures grew and were isolated. Nuclear staining has been made with Giemsa according to Boidin (1958).

VALIDITY OF THE TESTS.

The compatibility test as a tool for confirming conspecificity is nowadays widely accepted and thoroughly discussed by Boidin (1977, 1979). It is often argued that the number of individuals used in most compatibility tests is too small to be of any importance for taxonomists. Of course it is highly desirable to have a large number of different cultures from each species but for practical reasons usually only a few cultures are available.

However, a positive result in intercompatibility matings is considered as a strong evidence of conspecificity - even if only two different cultures are present. If there is a great geographical distance between the two specimens, it is most probable that they will be conspecific with specimens, not cultured, from intermediate localities.

This study also showed several cases of incompatibility between specimens which morphologically are very close or even indistinguishable from each other.

In those cases, differences in thallism may be responsible for incompatibility (Boidin 1977, 1979; Prillinger 1982) but there are other possible explanations.

Specimens which morphologically are more or less indistinguishable from each other but still incompatible ("sibling species") may be the result of genetical isolation prior to morphological separation (speciation in progress).

DISCUSSION.

As mentioned in the introduction, compatibility between N. American and European specimens was proved for most of the investigated species. Below, those species are listed for which compatibility (marked "+") or partial compatibility (marked "(+)") has been found. Those species which have been investigated before in this respect are marked "x" and the prior studies are cited in the list at the end of this paper.

Athelopsis subinconspicua	+
Basidioradulum radula	+, x
Ceraceomerulius serpens	+
Chaetoderma luna	+
Cylindrobasidium evolvens	+
Cystostereum murraii	+
Gloeocystidiellum porosum	(+)
Hyphoderma mutatum	+, x
H. praetermissum	+,(+)
H. puberum	+
H. roseocremeum	+,(+)
Hyphodontia arguta	+
H. barbajovis	+
H. hastata	+
H. quercina	+
H. rimosissima	(+)
H. subalutacea	+,(+)
Hypochnicium bombycinum	+
H. geogenium	+
H. karstenii	+,(+)
Merulius tremellosus	+
Metulodontia nivea	+
Peniophora incarnata	+, x
P. polygonia	+, x
P. violaceolivida	+
Phlebia centrifuga	+, x
P. radiata	+, x
P. rufa	+, x
Radulomyces confluens	+
Resinicium bicolor	+,(+)
R. furfuraceum	(+)
Tubulicrinis borealis	+
T. glebulosus	+
Xenasmatella filicina	+,(+)

In the following species different incompatibility groups have been detected (i.e. they are in fact species complex):

- *Cristinia helvetica*
- *C. mucida*
- *H. pallidum*
- *H. puberum*
- *Hyphodontia alutaria*
- *H. aspera*
- *H. breviseta*
- *H. breviseta*
- *H. rimosissima*
- *Phlebia rufa*
- *P. subochracea*
- *Sistotremastrum niveocremeum*
- *Tubulicrinis subulatus*

In most of the above species, small morphological differences have been found between the different incompatibility groups. These are discussed in connection with each species.
A surprising result is the great number of incompatibility groups in the *Hyphodontia aspera-breviseta* complex (see below).

No "new" species are described in this paper. Each case requires further study to determine the range of morphological variation. Further, specimens which were partly compatible are accepted as conspecific when no obvious morphological differences between them could be found.

RESULTS OF COMPATIBILITY TESTS WITH NOTES ON MORPHOLOGY OF FRUITBODIES AND CULTURES.

Data on specimens studied are categorized by slanted lines. Culture or specimen number/ substrate/ locality/ number of SS-(PS-)cultures or SS-numbers of compatible mating types. Compatible mating types are separated by a slant line, "/".

ATHELOPSIS SUBINCONSPICUA (Litsch.)Jül.
Syn.: *A. hypochnoidea* Jül.

Description, see Eriksson and Ryvarden 1973, p 139.

Material:
GB 348/ On a fallen trunk of Picea/ Sweden, Östergötland, Omberg/ 2/4,5.
GB 666/ On a fallen log/ Canada, British Columbia, Vancouver Island/ 3 SS.

GB 348 and GB 666 were compatible. No noticeable morphological differences observed in the fruiting bodies.

BASIDIORADULUM RADULA (Fr.) Nobles

Description, see Eriksson and Ryvarden (1975), p 519 (as *Hyphoderma radula* (Fr.)Wallr.).

Material:
GB 246/ On a fallen branch of Salix/ Sweden, Torne Lappmark, Abisko Nat. Park/ 2,4/5 + 2 additional SS.
GB 374/ On a fallen branch of Abies/ Austria, Steiermark, Hohenberg/ 1/2,4 .
GB 381/ On a fallen log of Abies/ Austria, Steiermark, Mt Schöckel/ 1,2/3,4,5 .
GB 386/ On a still-attached branch of Prunus cerasus/ Austria, Steiermark, W. of Schwanberg/ 1/2,3,4 .
GB 582/ On a fallen log of Populus/ Canada, Quebec, Gatineau Nat. Park/ 2 SS.
GB 783/ On a fallen log of a deciduous tree/ Canada, Quebec, Gatineau Nat. Park/ 1,3/2,4 .
GB 1016/ On a hanging branch of Abies/ Romania, distr. Suceava, Voronet/ 5 SS.

Compatibility existed between the above mentioned specimens. Though regarded as an easily determinable species there is considerable variation in the hymenophore. The teeth may be dense and flattened to scattered and round, with smooth, continous hymenium in between. Nobles (1967) also reported that smooth and only slightly tuberculate specimens were compatible with raduloid ones. She also proved conspecifity of N. American and European specimens.

Polarity: B. radula is tetrapolar (Biggs 1938).

CERACEOMERULIUS SERPENS (Fr.) Erikss.& Ryv.

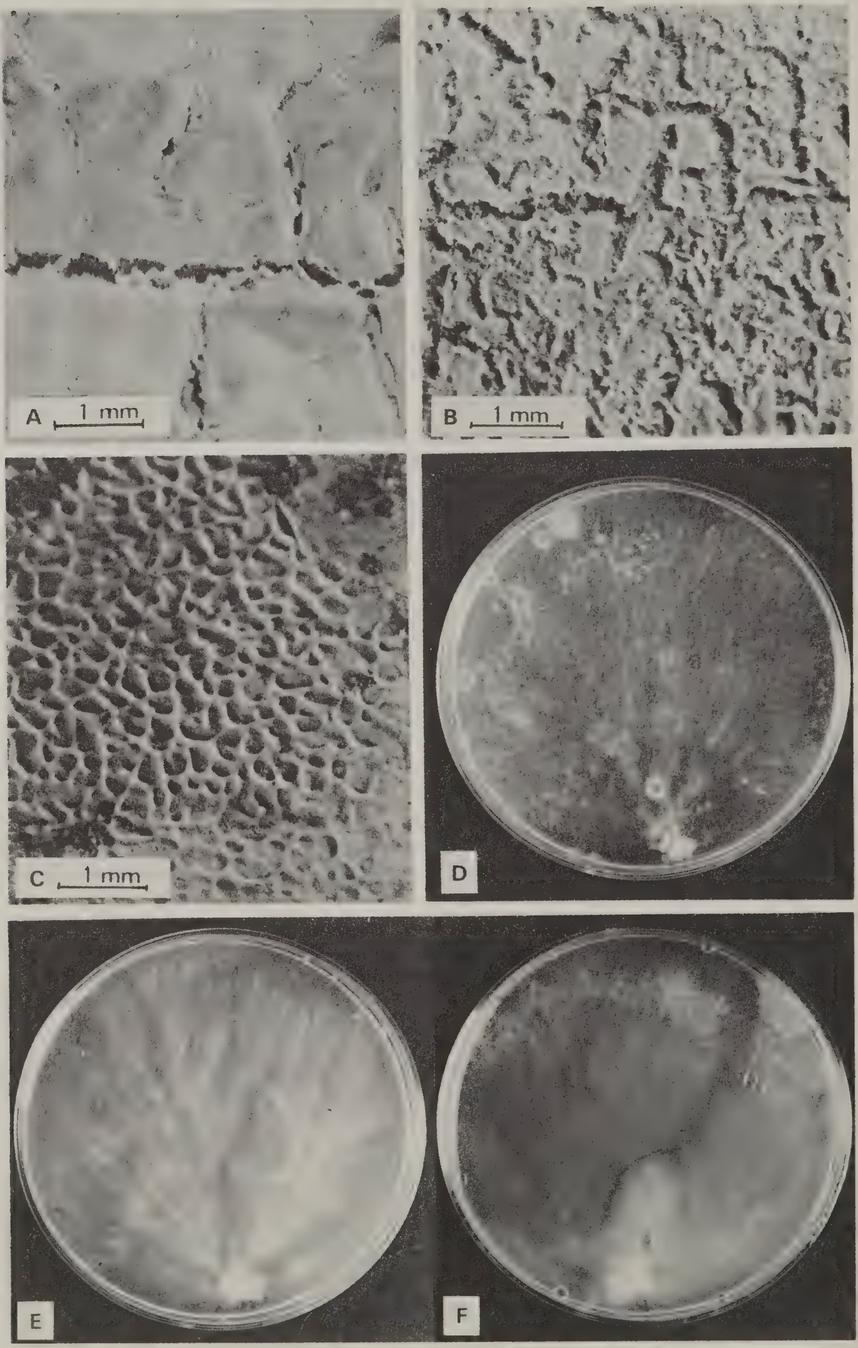
Description, see Eriksson and Ryvarden (1973), p 201.

Material:
GB 262/ On brown-rotted Salix/ Sweden, Torne Lappmark, Jieprenjåkk/ 1 SS, 1 PS.
GB 536/ On a fallen log of Pinus strobus/ Canada, Quebec, Cantley/ 1/2; 3/4.
GB 816/ On a fallen branch of Fagus/ Canada, Quebec, Gatineau Nat. Park/ 1 PS.

GB 262 and GB 536 were compatible. In di-mon matings GB 816 x GB 536/2 was positive (clamps formed) while GB 816 x GB 536/1,3,4, and GB 262 were negative.
There were minor morphological differences between these specimens (fig. 1 A,B,C):

GB 262 - Fruitbody rather thick, almost smooth, spores 4-4,5 x 2-2,5 µm.
GB 536 - Fruitbody slightly meruloid, spores rather small, 3,5-4 x 2-2,3 µm.
GB 816 - Fruitbody distinctly meruloid, spores as in GB 262.

Fig. 1. Ceraceomerulius serpens. Dried fruitbodies, A) GB 262, B) GB 536, C) GB 816. Cultures after six weeks growth, D) GB 816, E) GB 262, F) GB 536. - Photo T. Hallingbäck.


A 1 mm
B 1 mm
C 1 mm
D
E
F

CULTURE CHARACTERS in *C. serpens* (GB 262, GB 536, GB 816):

Aerial mycelium downy, slightly plumose (GB 262); slightly cottony, not plumose (GB 816); downy, not plumose (GB 536). Advancing zone appressed, fringed - bayed (GB 262, GB 816); even (GB 536).
Hyphae with clamps, ordinarily branched, 1,5-5 µm wide. Fig. 1 D,E,F.

Nobles' code (Nobles, 1965, with emendations by Boidin and Lanquetin, 1983):

GB 262: 2a. 3c. 7. 32. 36. 38. 44. 54. 58.
GB 536: 2. 3c. 32. 36. 38. 45. 55. 60.
GB 816: 2a. 3c. 7. 32. 36. 38. 44. 54. 58.

Oxidase reactions:

	Syringaldazine	1-Naphtol	Gum Guaiac	Guaiacol	p-cresol	L-Tyrosin
GB 262:	-	+	+	-	-	-
GB 536:	-	+	+	-	+	+
GB 816:	-	+	+	-	-	-

Polarity: Based on the mating of four SS (GB 536) *C. serpens* is tetrapolar, however, Ginns (1974) reported it to be bipolar.

CHAETODERMA LUNA (Rom. in Rog.& Jacks.) Parm.

Description, see Eriksson and Ryvarden (1973), p 231.

Material:
GB 251/ On a brown-rotted stump of Pinus/ Sweden, Torne Lappmark, Abisko Nat. Park/ 4 SS.
GB 464/ On a fallen branch of Picea engelmannii/ Canada, Alberta, Banff Nat. Park/ 2/3,6.
GB 494/ On a fallen log of Picea engelmannii/ Canada, Alberta, Banff Nat. Park/ 1,5,6/2,4.
GB 689/ On a fallen log of Pseudotsuga menziesii/ Canada, B.C., Vancouver Island/ 1/2.

Compatibility existed between all above mentioned specimens. The growth of haploid mycelia, however, was very slow.
Morphologically, the specimens are uniform, except for somewhat more narrow spores in the Canadian ones (3,8-5 µm versus 4-6 µm).

CRISTINIA

The results from the compatibility tests as well as a critical study of herbarium specimens indicates that there are some undescribed taxa in the vicinity of *C. mucida* and *C. helvetica*. In a provisory arrangement the two species are divided into four morphologically distinct groups.

CRISTINIA MUCIDA (Bourd. & Galz.) Erikss. & Ryv.

Description, see Eriksson and Ryvarden (1975), p 311.

GROUP I.
Fruitbody loosely attached, soft, sulphureous when live, cream - pale ochraceous when dry; hymenium pellicular, continous, with scattered, flattened teeth, in some specimens the hymenium meruloid, and in some parts quite smooth. When KOH is added, the fruitbody turns purple (or greyish in older specimens). Spores broadly ellipsoid - subglobose, 4,5-6 x 4-5,5 µm, with a prominent apiculus. Figs. 2 D, 3 A.

Cultures studied:
GB 630/ On a fallen log of Ulmus/ Canada, Quebec, Cantley/ 1 PS.
GB 800/ On a fallen log of a deciduous tree/ Canada, B.C., Vancouver/ 1 SS.

Herbarium material studied:
NH 7070/ On a fallen log of Alnus/ Canada, B.C., Vancouver Island.
NH 7561/ On a fallen log of a deciduous tree/ Canada, Quebec, Cantley.
Hb JE 3378/ On bark of Betula/ Sweden, Uppland, Erken.
Hb JE 8665, 8666/ On decayed trunk of Populus tremula/ Sweden, Uppland, Estuna par.
Doll 1965-09-29/ On Quercus robur/ DDR, Halle.

GROUP II.
The following specimens have a grandinioid - raduloid fruitbody, with cylindrical, blunt teeth, mostly grouped together. Hymenium continous, pellicular, small rhizomorphs present, spores 4-5 x 3-4 µm, with a small apiculus. All Canadian specimens have been collected in a fertile deciduous forest, South March, W of Ottawa, Ontario. Figs. 2 A, 3 B.

Culture studied:
GB 811/ On a fallen log of a deciduous tree/ 4 isolated SS, all produced clamps.

Herbarium material studied:
NH 7520/ On a fallen log of Ulmus.
NH 6475/ On a fallen trunk of Ulmus.
Hjm 12453, 12454/ On Picea abies/ Sweden, Östergötland, Omberg.

CRISTINIA HELVETICA (Pers.)Parm.

Description, see Eriksson and Ryvarden (1975), p 307.

GROUP III.
Fruitbody floccose - grandinioid, porulose when dry, loosely attached, light cream to pale ochraceous, with thin rhizomorphs. Spores broadly ellipsoid - subglobose, 4-5 x 3-4 µm, with a small apiculus. In N. Europe a morphologically uniform species. Figs. 2 C, 3 C.

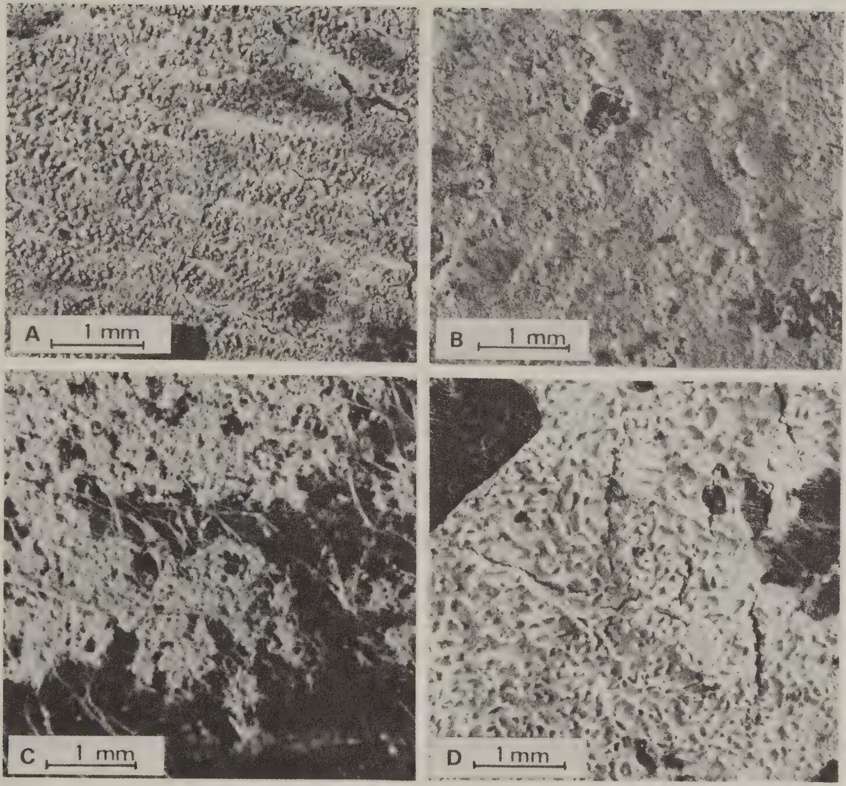


Fig. 2. Dried fruitbodies in Cristinia. A) C. mucida, group II, GB 811, B) C. helvetica, group IV, GB 550, C) C. helvetica, group III, GB 272, D) C. mucida, group I, GB 630. Photo T. Hallingbäck.

GROUP III.

Culture studied:
GB 272/ On a leaning log of Fagus/ Denmark, Jutland, Mols Bjerge/ 4/5 + 3 SS.

GROUP IV.
Two Canadian specimens which deviates from the N. European form by having a continous hymenium which is smooth or only slightly grandinioid. Fig. 2 B.

Culture and herbarium material:
GB 550/ On a fallen branch of Fagus/ Canada, Quebec, Gatineau Nat. Park/ 1,2,3/4 .
NH 7420/ On a fallen branch of Acer/ Canada, Ontario, Algonquin Prov. Park.

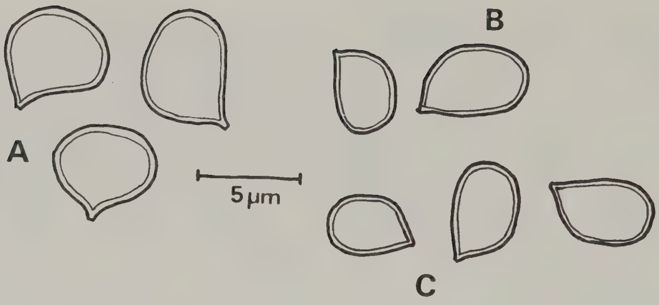


Fig. 3. Spores in A) Cristinia mucida, group I, GB 800, B) C. mucida, group II, GB 811, C) C. helvetica, group III, GB 272.

All cultures mentioned here were incompatible with each other.

CYLINDROBASIDIUM EVOLVENS (Fr.) Jül.

Description, see Eriksson and Ryvarden (1976), p 569.

Material:
GB 563/ On a fallen log of Acer/ Canada, Quebec, Gatineau Nat. Park/ 4 SS.
GB 706/ On a fallen twig of a deciduous tree/ Canada, B.C., Vancouver Island/ 1 PS.
GB 892/ On a fallen branch of Fagus/ Denmark, Jylland, Djursland, close to Rugård camping/ 5 SS.
GB 925/ On a fallen branch of Alnus/ Scotland, Perthshire, Kindrogan Field Sta./ 7 SS.
GB 1031/ On a fallen log of Picea/ Romania, Distr. Alba, W. of Cimpeni/ 5 SS.

These specimens were all compatible. No noticeable morphological differences were observed between their fruitbodies.
Polarity: Cylindrobasidium evolvens is tetrapolar (Robak 1942).

CYSTOSTEREUM MURRAII (Berk.&Curt.) Pouz.

Description, see Eriksson and Ryvarden (1975), p 323.

Material:
GB 129/ On a fallen, decayed trunk of Picea abies/ Sweden, Dalarna, Töfsingdalen Nat. Park/ 2,3/4.
GB 558/ On a fallen log of Acer/ Canada, Quebec, Cantley/ 1,2/4 .
GB 738/ On a fallen log of Betula/Canada, Ontario, Algonquin Prov. Park/ 2 SS.

Compatibility existed between GB 129, GB 558, and GB 738.
In Europe, C. murraii has only been found on Picea, while it in N. America preferably grows on hardwood. Despite the-

se ecological differences and some minor differences in the morphology (mentioned in Eriksson and Ryvarden, 1975) they obviously belong to the same taxon.
Polarity: C. murraii is tetrapolar (Boidin 1964).

GLOEOCYSTIDIELLUM POROSUM (Berk. & Curt.) Donk and G. CLAVULIGERUM (Höhn.& Litsch.) Nakas.

Descriptions and discussions: Eriksson and Ryvarden (1975), p 439, Hagström (1978), Nakasone (1982).

Material of G. porosum:
GB 38/ On a dead trunk of Ulmus/ Sweden, Skåne, Örups almskog/ 3 SS.
GB 61/ On a fallen branch of Fagus/ Denmark, Jylland, Mols Bjerge/ 1,6,8/5,10; 3,4/7,9.
GB 72/ On a fallen branch of Fraxinus/ Denmark, Jylland, Mols Bjerge/ 3/5 .
GB 324/ On a fallen twig of a deciduous tree/ Sweden, Närke, Herrfallsäng/ 4 SS.
GB 587/ On a fallen branch of Alnus/ Canada, Quebec, Gatineau Nat. Park/ 1/2 + 2 SS.
GB 690/ On a fallen branch of Alnus/ Canada, B.C., Vancouver Island/ 2/3 + 2 SS.
GB 937/ On a fallen branch of a deciduous tree/ Sweden, Göteborg, Rya skog/ 9 SS.
FP 101 749/ On Pinus resinosa/ USA, Wisconsin, LaCrosse County, Coulee Expt. For./ 1 PS.
FP 101 010/ On hardwood branch/ USA, Minnesota, Cloquet/ 1 PS.

The European specimens were compatible with each other. Partial compatibility between European and N. American specimens as well as between the N. American ones ("±" means that only few clamps were found, limited to the confrontation line):

	GB 38-1	GB 38-2	GB 61-1	GB 61-3	GB 61-9	GB 61-10	GB 72-3	GB 72-5	GB 324-1	GB 324-2	GB 587-1	GB 587-2	GB 690-2	GB 690-3
GB 587-1	±	-	+	-	-	+	-	-	±	±		+	-	-
GB 587-2	-	-	+	-	-	+	+	+	+	±	+		+	+
GB 690-2	±	±	+	-	-	+	-	-	+	+	-	+		+
GB 690-3	±	±	±	-	-	±	-	±	±	+	-	+	+	
FP 101 010	-	-	-	-	-	-	-	-	-	-	+	+		
FP 101 749	-	-	-	-	-	-	-	-	-	-	+	+		

The reduced compatibility with FP 101 749 and FP 101 010 could possibly be explained by senescence of these cultures (isolated 1979 and 1972).

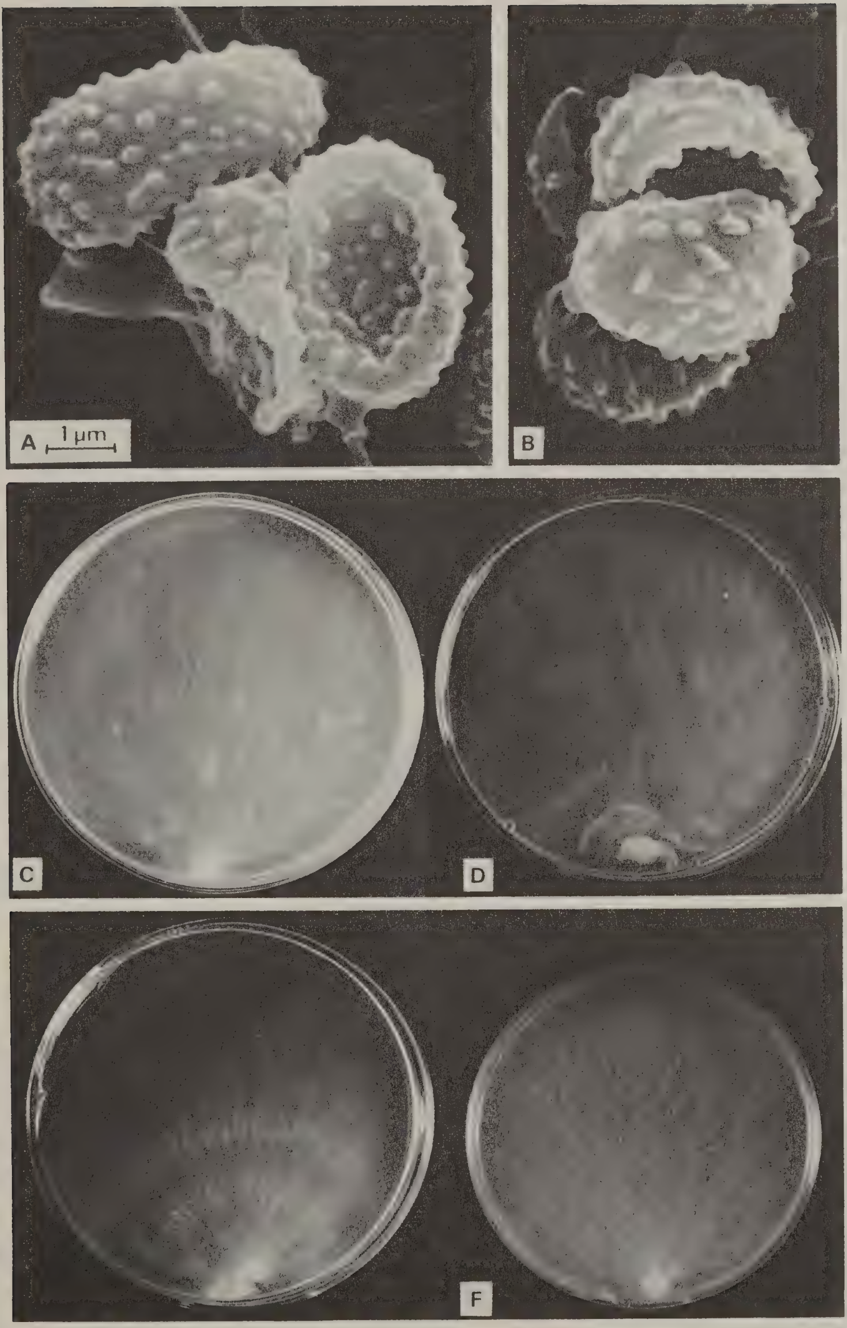
Material of *G. clavuligerum*:
GB 554/ On a fallen log of a deciduous tree/ Canada, Quebec, Gatineau Nat. Park/ 1/2 .
GB 656/ On a fallen log/ Canada, B.C., Vancouver Island/ 4 SS.
GB 670/ On a fallen branch of a deciduous tree/ Canada, B.C., Vancouver Island/ 1,3/4 .
GB 676/ On a fallen branch of Alnus/ Canada, B.C., Vancouver Island/ 1/3,4 .
GB 677/ On a fallen branch of Pseudotsuga menziesii/ Canada, B.C., Vancouver Island/ 7 isolated SS-cultures, all clamped. Neohaplonts were used in intercompatibility matings.
HHB 10461, HHB 7891/ On Acer saccharum/ USA, Michigan, Marquette County, Huron Mt. Club/ 1 PS of each.

Compatibility between the above GB-cultures of *G. clavuligerum*. In HHB 10461 and HHB 7891 clamps were formed only in the combination HHB 7891 x GB 554/2, and GB 670/1,4 (possibly depending on senescence of the former two cultures). No visible barrier was formed in the combinations between HHB 10461, HHB 7891 and other cultures of *G. clavuligerum*.
Complete incompatibility between cultures of *G. porosum* and *G. clavuligerum* and a visible border line was also formed between the mycelia.

G. clavuligerum and *G. porosum* are closely related species. Nakasone (1982) itemized the differences in their fruitbody morphology as follows:

G. porosum	*G. clavuligerum*
Spores cylindrical - ellipsoid	Spores ellipsoid - subglobose
Elongated, sinous pseudocystidia	Short pseudocystidia with apical constrictions
Fruitbodies usually on bark	Fruitbodies usually on decorticated wood

In the present study the differences in spore shape has been confirmed and found to be a constant feature even if the spore length in *G. porosum* varies considerably (see Hagström, 1978). Moreover, the tubercles on the spore walls are more prominent and easily observed at 500x magnification in *G. clavuligerum* but they are almost invisible in *G. porosum* (Figs. 4 A,B, 5 A,B). The pseudocystidia are generally shorter in *G. clavuligerum* but some sinous and elongated ones can be found. In both species "birooted" cystidia ("plagiogloeocystidia" in Boidin et al , 1980; "cystidia laterale" in Hagström, 1978) are found. In the 13 Canadian collections studied, the distribution between specimens growing on bark versus on decorticated wood was essentially equal:
G. porosum: 3 on bark, 3 on wood; *G. clavuligerum*: 3 on bark, 4 on wood.


A
1 µm
B
C
D
F

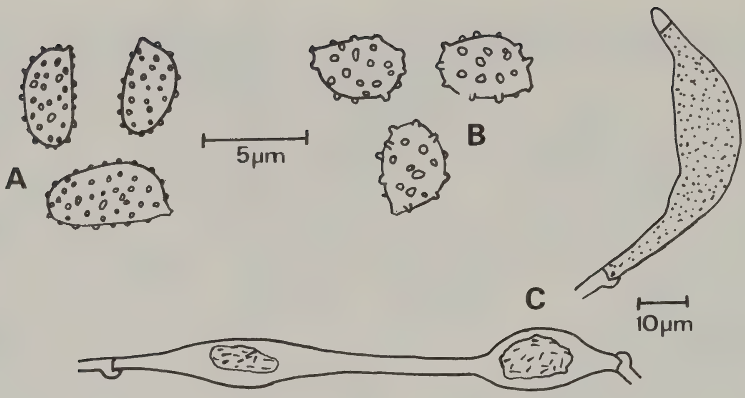


Fig. 5. A) Spores in Gloeocystidiellum porosum, GB 72, B) G. clavuligerum, GB 676; C) G. porosum, gloeocystidium-like structures in culture, GB 587.

Spores sizes from European and N. American specimens when measured from spore prints:
G. porosum: 4,5-5,4-7 x 2,5-2,9-3,5 µm.
G. clavuligerum: 4-4,2-5 x 2,8-3,1-3,5 µm.

One specimen of G. porosum (GB 937) had a deviating spore size (4,5-5 x 3-3,5 µm) which is very close to G. clavuligerum.
The type of G. clavuligerum has been studied (Gloeocystidium clavuligerum/ Austria, Kolbeter, Wienerwald/ 1902, coll. v.Höhnel, in FH) . As mentioned by Nakasone (1982), it differs from N. American specimens by having a very thin fruitbody and projecting gloeocystidia. I found that the spores are distinctly larger (though variable) in the type collection, 4-7 x 3,3-5 µm. This type may not be conspecific with the other N. American specimens. However,more extensive studies are needed to confirm this view.

CULTURE CHARACTERS in G. porosum (GB 324, GB 587) and G. clavuligerum (GB 676):

Aerial mycelium downy (GB 324, GB 587); slightly differentiated in strands (GB 676). Advancing zone even, appressed. Hyphae ordinarily branched, with clamps, 2-4 µm wide (GB 324, GB 587); 1,5-4,5 µm (GB 676); wide hyphae straight, sparsely septate and branched, narrow hyphae richly branched (GB 676); gloeocystidium-like structures terminal or

Fig. 4. Spores in A) Gloeocystidiellum porosum, GB 690, B) G. clavuligerum, GB 676. Cultures after six weeks growth, C) G. porosum, GB 587, D) G. clavuligerum, GB 676, E) Hyphoderma praetermissum, GB 692, F) do., GB 402. - Photo T. Bergquist (A, B), T. Hallingbäck (C - F).

intercalary, 20-100 x 6-16 µm; with strongly sulfo-positive contents (GB 324, GB 587), weakly sulfopositive in GB 676. Figs. 4 C,D, 5 C.

Code:
GB 324: 2a. 3c. 7. 15a. 32. 36. 38. 46. 54. 58.
GB 587: 2a. 2b. 3c. 15a. 32. 36. 38. 45. 54. 58.
GB 676: 2a. 3c. 15(a).(26). 32. 36. 38. 45. 54. 58.

Oxidase reactions:

	Syringaldazine	1-Naphtol	Gum Guaiac	Guaiacol	p-cresol	L-Tyrosin
GB 324:	+	+	+	+	-	-
GB 587:	(+)	+	+	+	-	+
GB 676:	+	+	+	+	-	-

Polarity: *G. porosum* is tetrapolar (Tassinari 1956).

HYPHODERMA MUTATUM (Peck) Donk

Description, see Eriksson and Ryvarden (1975), p 491; Mc Keen (1952).

Material:
GB 529/ BRD, Nördliche Oberrheinebene, Kühkopf/ 1 PS.
GB 592/ On a fallen branch of Tilia/ Canada, Quebec, Cantley/ 1/2,3,4 .

Compatibility between GB 529 and GB 592. No morphological differences between the fruitbodies. According to the substrate in GB 592 (not Populus!), this specimen belongs to *H. mutatum* group B (McKeen, 1952). McKeen found, in a study of Canadian cultures, that specimens collected on Populus (group A) were completely intercompatible with each other but only partly compatible with group B - composed of specimens collected on other broadleaved hosts than Populus. The specimens within group B were completely intercompatible.
Polarity: *H. mutatum* is bipolar (McKeen 1952).

HYPHODERMA PALLIDUM (Bres.) Donk

Description, see Eriksson and Ryvarden (1975), p 503.

Material:
GB 457/ On Picea/ Norway, Nordland, Rana/ 2 SS.
GB 515/ Sweden, Västergötland, Särö Västerskog/ 1/2 .
GB 710/ On a fallen coniferous log/ Canada, B.C., Vancouver Island/ 1 PS .
GB 959/ On a fallen, coniferous log/ Scotland, Perthshire, Kindrogan Field Sta./ 8 SS.

Compatibility between GB 457, GB 515 and GB 959, incompatibility with GB 710.

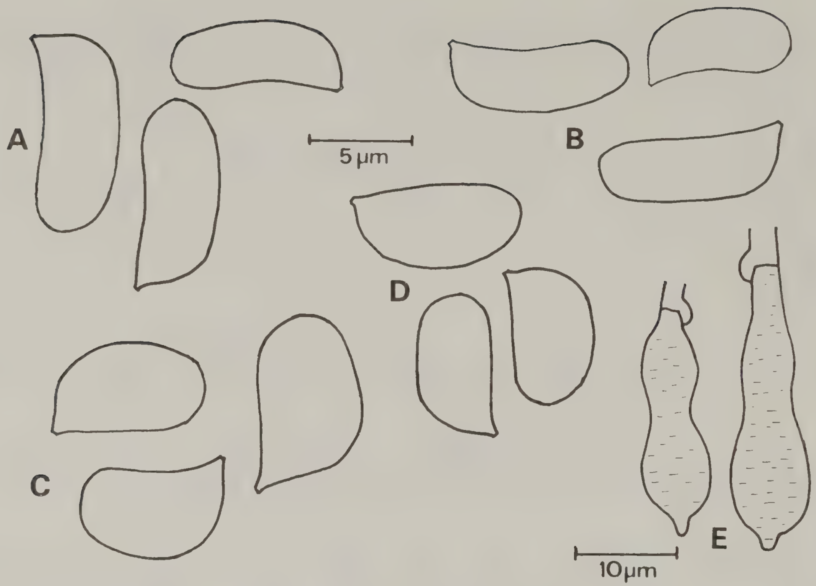


Fig. 6. Spores in A) Hyphoderma palidum, GB 457, B) H. aff. pallidum, GB 710, C) H. tsugae, GB 767, D) H. aff. tsugae, GB 599, E) Mucronate cystidia in H. aff. tsugae, GB 599.

GB 710 had somewhat smaller spores (7,5-8,1-9 x 3-3,1-3,3 µm) than the European specimens (8-9,3-11 x 3,5-3,8-4 µm). Four additional herbarium specimens from Canada were studied and found to agree with GB 710. Fig. 6.

HYPHODERMA TSUGAE (Burt) Erikss. & Strid

Description, see Eriksson and Ryvarden (1975), p 541.

Material:
GB 767/ On a fallen branch of Picea/ Canada, Ontario, Algonquin Prov. Park/ 3 SS + 2 PS.
GB 599/ On a fallen branch of Pinus strobus/ Canada, Quebec, Cantley/ 1,2,3/4 .

GB 767 and GB 599 are incompatible with each other as well as with the above mentioned cultures of H. pallidum.
GB 599 differs from GB 767 by having smaller spores (6,5-8,5 x 3,5-4 µm, and 7-9 x 4,5-5 µm resp.) and by the presence of mucronate cystidia except for the subulate and clavate ones. In both specimens, some spores have reddish-brown, resinous contents. Fig. 6.

HYPHODERMA PRAETERMISSUM (Karst.) Erikss. & Strid

Description, see Eriksson and Ryvarden (1975), p 505.

Material:
GB 275/ On a fallen log of Pinus/ Denmark, Jylland, Mols Bjerge/ 1/2.
GB 402/ On a fallen, coniferous branch/ Austria, Steiermark, W. of Schwanberg/ 1/2 .
GB 465/ On a stump of Picea engelmannii/ Canada, Alberta, Banff Nat. Park/ 1,3,4/5,6 .
GB 669/ On a fallen branch/ Canada, B.C., Vancouver Island/ 1 SS.
GB 692/ On a fallen log of Alnus/ Canada, B.C., Vancouver Island/ 1 PS.

Compatibility existed between GB 275, GB 402, and GB 465. Partial compatibility according to the following:

	GB 275-1	GB 275-2	GB 402-1	GB 402-2	GB 465-1	GB 465-5	GB 692-PS
GB 669-1	-	-	+	+	-	-	+
GB 692-PS	-	-	+	-	-	-	

H. praetermissum is considered either a variable species or a species collective (Eriksson and Ryvarden, 1975). One variable feature is the projecting, usually capitate cystidia which can vary in frequency, size, shape, and in the nature of encrustation. The above tested specimens were morphologically rather uniform but the variation in capitate cystidia is illustrated in fig. 7 A-E. Both crystalline (GB 275, GB 402, GB 669, GB 692) and amorphous encrustation (GB 465) was noticed; the amorphous encrustation was stained by cottonblue. The capitate cystidia in GB 669 and GB 692 differed by having slightly thickened walls.

CULTURE CHARACTERS in *H. praetermissum* (GB 402, GB 692):

Aerial mycelium downy. Advancing zone appressed, even (GB 692); slightly fringed (GB 402). Hyphae with clamps, ordinarily branched, 1-7 µm wide (GB 402); 2,5-8 µm wide (GB 692); partly filled with an oily substance (light refractive); some hyphae inflated (GB 692); stephanocysts; small capitate hyphal endings. Figs. 4 E,F, 7 F,G.

Code:
GB 402: 2a. 3c. 13. (26). 32. 36. 38. 45. 55. 59.
GB 692: 2a. (2b). 3c. 13. 26. 32. 36. 38. 46. 54.

Oxidase reactions:

	Syringaldazine	1-Naphtol	Gum Guaiac	Guaiacol	p-cresol	L-Tyrosin
GB 402:	+	–	–	+	–	–
GB 692:	+	–	+	+	(+)	–

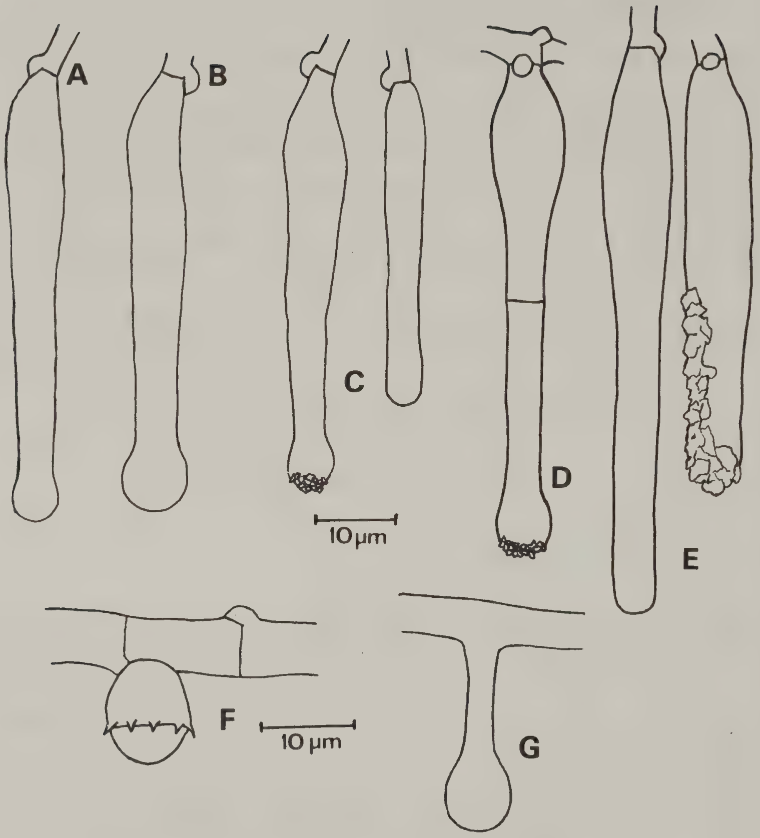


Fig. 7. Hyphoderma praetermissum, capitate or cylindrical cystidia in A) GB 275, B) GB 402, C) GB 465, D) GB 692, E) GB 669. Polyspore mycelium in culture, F) stephanocyst, GB 402, G) capitate cystidium, GB 692.

Polarity: H. praetermissum is bipolar or homothallic (Boidin 1950).

HYPHODERMA PUBERUM (Fr.)Wallr.

Description, see Eriksson and Ryvarden (1975), p 513.

Material:
GB 58/ On a fallen branch of Quercus/ Denmark, Jylland, Mols Bjerge/ 2 SS.
GB 321/ On a fallen branch of deciduous tree/ Sweden, Västmanland, Högholmsskär in Lake Mälaren/ 1,3/2 .
GB 537/ On a fallen log of Pinus strobus/ Canada, Quebec, Cantley/ 1,3/2 .
GB 652/ On a fallen, coniferous log/ Canada, B.C., Garibaldi Prov. Park/ 1,3/2 .

GB 58, GB 321, GB 537 were compatible with each other. GB 652, however, is incompatible with all these specimens. All four specimens are morphologically uniform, but GB 652 deviates by having cystidia which bear a globule of yellowish, resinous material on the top. These cystidia are little differentiated and look like immature basidia. The globule is 14-20 µm wide and stained by cotton blue. The same kind of cystidia have been reported from *H. praetermissum* (see above and Eriksson and Ryvarden, 1975, p 507). Two additional specimens of *H. puberum* from Canada with amorphous globules have been studied.

Polarity: *H. puberum* is bipolar (Biggs 1938).

HYPHODERMA ROSEOCREMEUM (Bres.)Donk

Description, see Eriksson and Ryvarden (1975), p 523.

Material:
GB 310/ On a fallen branch of a deciduous tree/ Sweden, Västmanland, Högholmsskär in Lake Mälaren/ 1/2 .
GB 470/ On a fallen log of Abies lasiocarpa/ Canada, B.C., Revelstoke Nat. Park/ 1,4,6,7,8/2,3,5.
GB 472/ On a fallen log of Abies lasiocarpa/ Canada, B.C., Yoho Nat. Park/ 1 SS.
GB 477/ On a fallen log of Abies lasiocarpa/ Canada, B.C., Revelstoke Nat. Park/ 1,2,3,6/4,5.
GB 702/ On a fallen log of Abies lasiocarpa/ Canada, B.C., Vancouver Island/ 1,3/2,4 .
GB 941/ On a fallen log of Betula/ Scotland, Perthshire, Struan Birchwood near Blair Atholl/ 7 SS.

Compatibility existed between GB 470, GB 472, GB 477, GB 702, and GB 941. Partial compatibility between this group and GB 310:

	GB 470-1	GB 470-2	GB 472-1	GB 477-1	GB 477-4	GB 702-1	GB 702-2	GB 941-1	GB 941-2
GB 310-1	+	-	-	+	+	+	+	+	+
GB 310-2	+	-	-	-	-	-	+	+	+

There is variation between the specimens in the choice of substrate. All Canadian collections are from coniferous wood, while the European ones were collected on wood from deciduous trees, which is the normal substrate in N. Europe.
The specimens are morphologically uniform except for the spore size. The spores in the Canadian as well as in the Scottish collections are relatively big, 9-11 x 3,5-4,5 µm (when measured from spore-prints) versus 8-10,5 x 3-4 µm in GB 310. Eriksson and Ryvarden (1975) report the spore size to be 9-12 x 3-4 µm.

HYPHODONTIA ALUTARIA (Burt) John Erikss. and *H. ARGUTA* (Fr.) John Erikss.

Description, see Eriksson and Ryvarden (1976), p 605, 609.

Material of *H. alutaria*:
GB 41/ On a fallen log of Quercus/ Sweden, Skåne, Hallands Väderö/ 1,5/2,4 + 1 SS.
GB 181/ On a fallen log of Picea/ Sweden, Östergötland, Omberg/ 1/7 + 1 SS.
GB 207/ On deciduous wood/ Sweden, Göteborg, Botanical Garden/ 1/6; 2/5.

Material of *H. arguta*:
GB 344/ On a fallen branch of a deciduous tree/ Sweden, Västmanland, Högholmsskär in Lake Mälaren/ 1/3,4 + 1 SS.
GB 798/ On a fallen log of a deciduous tree/ Canada, B.C., Vancouver Island/ 4 SS.
GB 1083/ On a fallen branch of a deciduous tree/ Romania, Distr. Suceava, W. of Suceava/ 1 PS.

GB 181 and GB 207 were compatible and GB 344, GB 798, and GB 1083 were compatible but these two groups were incompatible and neither were compatible with GB 41.
The specimens determined as *H. alutaria* are very homogenous in the micromorphology, however, GB 41 deviates clearly from GB 181 and GB 207 by having much smaller - but distinct - tubercles on the hymenium. It is easily observed when comparing the different specimens under the lens (12X magnification). GB 41 obviously represents a taxon of it's own but species descriptions must wait until more material have been cultured and the micromorphological variation is fully understood.
The three specimens of *H. arguta* are also very similar under the microscope, differing only in the size of the aculei on the fruitbodies, varying between 0,2 - 2 mm. Fig. 8.

CULTURE CHARACTERS in *H. alutaria* (GB 41, GB 207):

Aerial mycelium absent (GB 207); downy (GB 41); mat zonate. Advancing zone even, appressed. Hyphae with clamps, ordinarily branched, 1,5-5 µm wide; more or less regular, moniliform swellings on hyphae as well as scattered, small bulbs directly on the hyphae (GB 41). Fig. 9 A.

Code:
GB 41: 2a. 3c. 26. 32. 36. 38. 44. 54. 58.
GB 207: 2a. (2b). 3c. 7. 32. 36. 38. 47 (55 mm). 54. 60.

Oxidase reactions:

	Syringaldazine	1-Naphtol	Gum Guaiac	Guaiacol	p-cresol	L-Tyrosin
GB 41:	+	+	+	+	−	−
GB 207:	(+)	+	(+)	+	(+)	−

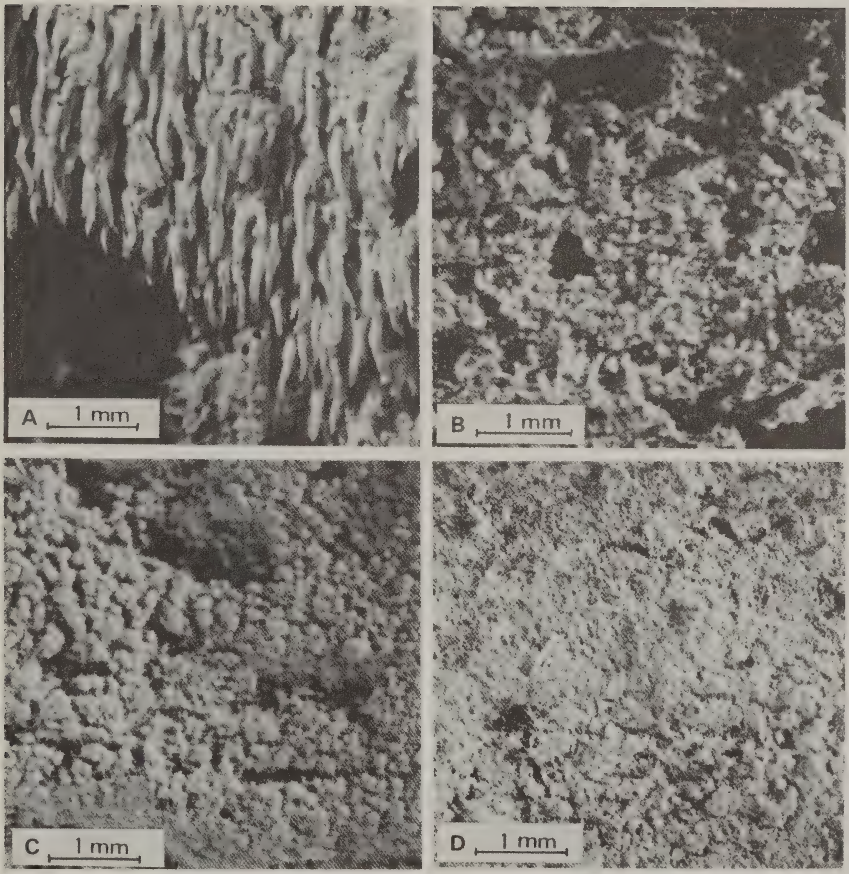


Fig. 8. Dried fruitbodies. A) Hyphodontia arguta, GB 798, B) do., GB 344, C) H. alutaria, GB 41, D) GB 207. - Photo T. Hallingbäck.

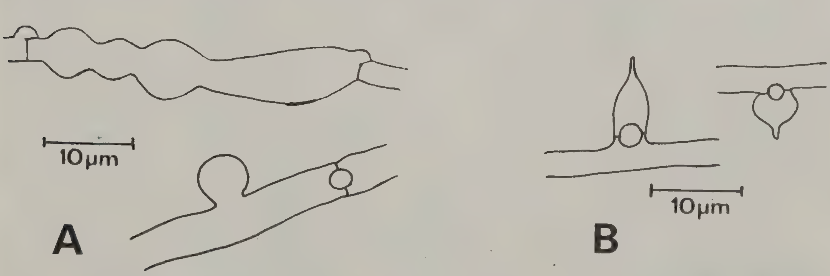


Fig. 9. Culture details in, A) Hyphodontia alutaria, moniliform swellings on a hypha, small bulb on a hypha, GB 41, B) H. subalutacea, small globose - cylindrical structures with small pegs, GB 650.

CULTURE CHARACTERS in *H. arguta* (GB 798):

Aerial mycelium downy. Advancing zone even, appressed. Hyphae ordinarily branched, 2-3 µm wide. Fig. 10 A.

Code:
GB 798: 2a. 2b. 3c. 7. 32. 36. 38. 47(30 mm). 54. 58.

Oxidase reactions:

	Syringaldazine.	1-Naphtol	Gum Guaiac	Guaiacol	p-cresol	L-Tyrosin
GB 798:	+	+	+	+	-	+

Polarity: Both *H. alutaria* and *H. arguta* are tetrapolar (Faisal 1981, Boidin and Lanquetin, 1965).

HYPHODONTIA ASPERA (Fr.) John Erikss. and *H. BREVISETA* (Karst.) John Erikss.

Hyphodontia aspera and *H. breviseta* are two well-defined species; for descriptions see Eriksson and Ryvarden (1976), p 613 and p 625. However, there are lots of specimens which resemble both species and for practical reasons these have often been referred to either *H. aspera* or *H. breviseta*. An undesired consequence has been that the species concepts of the two species have widened and there has been a problem how to correctly determine intermediate specimens.

In the narrow, morphological concept there are four specimens of *H. aspera* and three of *H. breviseta* represented in this study. Still among the four specimens of *H. aspera* only two are compatible with each other while all three specimens of *H. breviseta* are incompatible with each other.

However, several other specimens are morphologically intermediate and they too represent several incompatibility groups. For practical reasons they are referred to as *H. aspera-breviseta*-group. It is quite obvious that much work has to be done with this group before the species concepts are determined.

HYPHODONTIA ASPERA

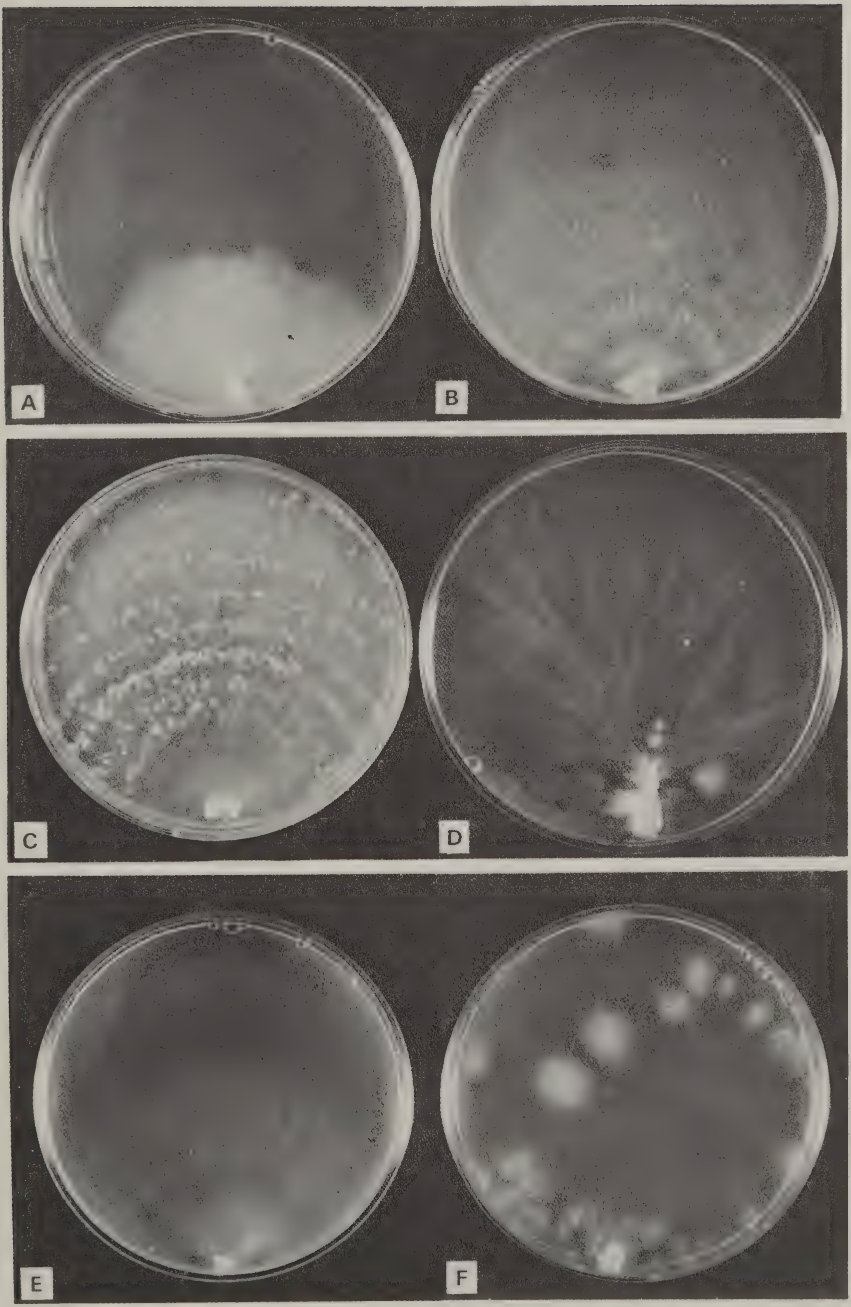
GB 413/ On a fallen log/ Sweden, Västmanland, Rytterna/ 1/4,5 + 1 SS.

GB 196/ On a fallen log of Alnus/ Sweden, Göteborg, Botanical Garden/ 4 isolated SS, all clamped. Neohaploidization resulted in stable, haploid cultures. Di-mon matings between these neohaplonts and clamped cultures of GB 196 resulted in few clamps on the haploid side.

GB 1093/ On a fallen log of Picea/ Romania, Distr. Suceava, forest reserve "Poiana Stampei"/ 8,13/1,6,9; 4,5,10/12.

GB 1094/ On a fallen log of Picea/ Romania, Distr. Alba, W. of Cimpeni/ 2/4,5 .

Fig. 10. Cultures after six weeks growth. A) *Hyphodontia arguta*, GB 798, B) *H. aspera-breviseta* - group, GB 274, C) *H. aspera*, GB 196, D) *H. aspera-breviseta* - group, GB 605, E) do., GB 628, F) do., GB 640. - Photo T. Hallingbäck.


A
B
C
D
E
F

GB 1093 was compatible with GB 1094. All other combinations within this species were incompatible.

HYPHODONTIA BREVISETA

GB 81/ On a decayed trunk of Picea abies/ Sweden, Västergötland, Björketorp/ 2/4 + 5 SS.
GB 681/ On a fallen log of Pseudotsuga menziesii/ Canada, B.C., Vancouver Island/ 1 PS.
GB 1050/ On a fallen log of Picea/ Romania, Distr. Suceava, forest reserve "Poiana Stampei"/ 5 SS.

These three specimens were morphologically indistinguishable from each other and were besides infected by the same hyphomycete-parasite which is so typical for this species (see Eriksson and Ryvarden, 1976). Nevertheless, they were incompatible.

HYPHODONTIA ASPERA-BREVISETA-group

Group I.
GB 274/ On a fallen branch of Picea/ Denmark, Jylland, Mols Bjerge/ 1,3,5/2,7 + 2 SS.
GB 316/ On a fallen branch of Pinus/ Sweden, Småland, N. Kvill Nat. Park/ 2 SS.

These two cultures were compatible with each other.

Group II.
GB 225/ On a leaning log of Pinus/ Sweden, Halland, Särö Västerskog/ 1/2 .

Group III.
GB 605/ On a fallen log of Abies balsamea/ Canada, Quebec, Cantley/ 1,3,4/ 2 .

Group IV.
GB 740/ On a fallen log of Abies balsamea/ Canada, Ontario, Algonquin Prov. Park/ 1,3/4 .

Groups I-IV were crossed against each other but no clamps were formed. Besides, from two additional specimens PS-cultures were obtained:

GB 628/ On a fallen log of Pinus strobus/ Canada, Quebec, Cantley.
GB 640/ On a fallen log of Abies lasiocarpa/ Canada, B.C., Yoho Nat. Park.

In di-mon matings, these cultures were incompatible with GB 605 and GB 740.

The specimens listed here under Hyphodontia aspera-breviseta-group are morphologically closer to H. aspera or H. breviseta than to any other taxon described in Eriksson and Ryvarden (1976). No distinct, separating characters for this group have been found.

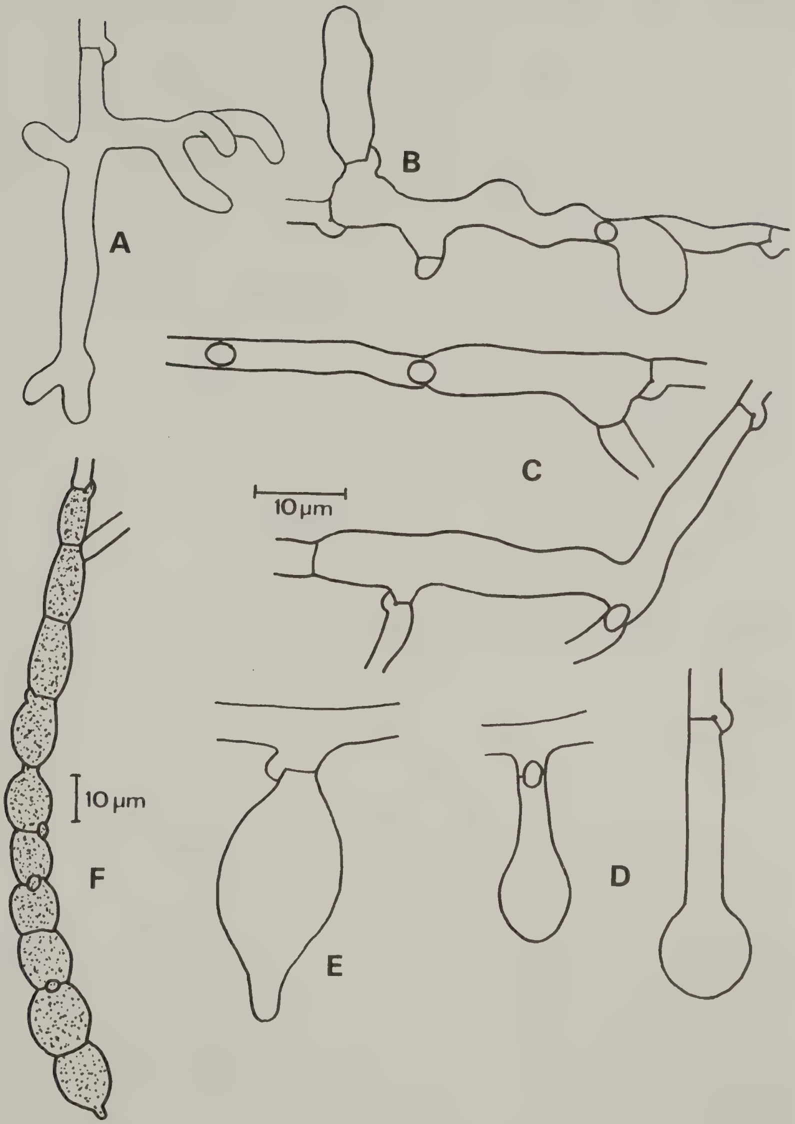


Fig. 11. Hyphodontia aspera-breviseta - group, culture details, A) densely branched hypha, GB 605, B) inflated hypha, GB 605, C) do., GB 274, D) capitate hyphal endings, GB 628; H. aspera, E) gloeocystidium, GB 196, F) moniliform inflations, GB 196.

CULTURE CHARACTERS (GB 81, GB 196, GB 274, GB 605, GB 628, GB 640).

Aerial mycelium absent (GB 605, GB 628); downy (GB 81, GB 196, GB 274, GB 640). Advancing zone even, appressed. Hyphae with clamps, 1,5-5 µm wide; ordinarily branched (GB 81, GB 196, GB 274, GB 640); some of the narrower hyphae densely branched and irregularly curved (GB 605, GB 628); inflations on hyphae (GB 81, GB 274, GB 605, GB 628, GB 640); moniliform inflations (GB 196); gloeocystidium-like structures (GB 196, GB 274, GB 605); allocysts (GB 81, GB 605, GB 628); subglobose conidia, 4-6 µm in diam., produced singly (GB 640); scattered subcultures, probably due to dispersal of conidia (GB 640) but conidiophores not seen. Figs. 10 B-F, 11.

Code:
GB 81: 2a. 3c. 26. 32. 36. 38. 47 (12 mm). 55. 58.
GB 196: (2a). 3c. 15b. 26. 32. 36. 38. 42. 54.
GB 274: 1. 3c. 15b. 26. 32. 36. 38. 46. 55. 58.
GB 605: 2a. (2b). 3c. 15b. 26. 32. 36. 38. 44. 55. 58.
GB 628: 2a. 3c. 26. 32. 36. 38. 46. 55.
GB 640: 2a. 3c. 26. 33. 36. 38. 47 (15 mm). 55.

Oxidase reactions:

	Syringaldazine	1-Naphtol	Gum Guaiac	Guaiacol	p-cresol	L-Tyrosin
GB 81:	+	+	+	+	-	-
GB 196:	-	-	(+)	-	-	-
GB 274:	-	-	-	-	-	-
GB 605:	+	-	+	+	(+)	-
GB 628:	+	+	+	+	-	-
GB 640:	+	-	-	(+)	-	-

HYPHODONTIA BARBAJOVIS (Fr.) John Erikss.

Description, see Eriksson and Ryvarden (1976), p 619.

Material:
GB 218/ On a fallen log of Betula/ Sweden, Halland, Särö Västerskog/ 2/3,5 + 1 SS.
GB 228/ On a fallen log of Pinus/ Sweden, Halland, Särö Västerskog/ 5/1,2,6,7 + 1 SS.
GB 539/ On a fallen log of Abies balsamea/ Canada, Quebec, Cantley/ 1/2,3,4.
GB 598/ On a fallen branch of Pinus strobus/ Canada, Quebec, Cantley/ 1,2,5/4 + 1 SS.
GB 770/ On a fallen log of Pinus strobus/ Canada, Quebec, Cantley/ 1/2.

Compatibility between all above mentioned specimens, however, between the Canadian collections partial incompatibility was noted (probably partial homogenic incompatibility) as they were collected within the same area.

	GB 598-4	GB 598-5	GB 770-1	GB 770-2
GB 539-1	-	+	-	-
GB 539-2	-	+	+	-
GB 598-4		+	-	-
GB 598-5	+		+	+

The specimens are homogenous in the micromorphology while the size of the aculei varies. It is interesting that the 5 specimens of H. barbajovis collected by me in Canada (Ottawa area), were all on coniferous wood. In Europe, the species is normally found on wood from deciduous trees.
Polarity: H. barbajovis is tetrapolar (Boidin and Lanquetin 1965).

HYPHODONTIA HASTATA (Litsch.) John Erikss.

Description, see Eriksson and Ryvarden (1976), p 647.

Material:
GB 347/ On coniferous wood/ Sweden, Småland, Marieholm/ 1/2 .
GB 694/ On a fallen branch of a coniferous tree/ Canada, B.C., Vancouver Island/ 1/2,3,4 .

Compatibility between GB 347 and GB 694. No noticeable differences in morphology was found.

HYPHODONTIA QUERCINA (Fr.) John Erikss.

Description, see Eriksson and Ryvarden (1976), p 667.

Material:
GB 330/ On a fallen branch of a deciduous tree/ Sweden, Närke, Herrfallsäng/ 2/4 + 2SS.
GB 334/ On a fallen branch of a deciduous tree/ Sweden, Västmanland, Högholmsskär in Lake Mälaren/ 3 SS.
GB 393/ On a fallen log of a deciduous tree/ Austria, Steiermark, St. Radegund/ 1,2/3,4,5.
GB 414/ On a fallen log of a deciduous tree/ Austria, Steiermark, Graz/ 3 SS.
GB 658/ On a fallen branch of Acer/ Canada, B.C., Vancouver Island/ 2 SS.
GB 1054/ On a fallen branch of Fagus/ Romania, Distr. Suceava, Codrul Secular Slatioara/ 5 SS.

Compatibility between all these cultures. In the micromorphology the specimens are uniform. However, remarkable differences in size and shape of the aculei from different

fruitbodies were noticed. When young, the aculei are small, cylindrical, with blunt apices, single; when mature up to 3 mm long, mostly grouped together, cylindrical or flattened, with or without small projections, apically fimbriate, blunt or subulate. In GB 414, the individual aculei are still more branched (H. quercina forma coralloides Hallenb. - see Hallenberg, 1980). Figs. 12 A, B.
Polarity: H. quercina is tetrapolar (Boidin and des Pomeys, 1961).

HYPHODONTIA RIMOSISSIMA (Peck) Gilbn.

Syn.: H. verruculosa Erikss. & Hjortst.

Description, see Eriksson and Ryvarden (1976), p 681 (under H. verruculosa).

Material:
GB 85/ On a fallen branch of Fraxinus/ Denmark, Jylland, Mols Bjerge/ 2/1,3 .
GB 273/ On a fallen branch of Fraxinus/ Denmark, Jylland, Mols Bjerge/ 9 isolated SS, all clamped.
GB 345/ On a fallen branch of a deciduous tree/ Sweden, Västmanland, Högholmsskär in Lake Mälaren/ 3 SS.
GB 557/ On a fallen branch of a deciduous tree/ Canada, Quebec, Gatineau Nat. Park/ 1/2,4 + 1 SS.
GB 565/ On a fallen branch of Acer/ Canada, Quebec, Gatineau Nat. Park/ 4 SS.
GB 571/ On a fallen branch of Alnus/ Canada, Quebec, Gatineau Nat. Park/ 4 SS.

Compatibility between the European cultures, GB 85, GB 273, and GB 345; partial compatibility between these and the Canadian cultures. Between the Canadian cultures only partial compatibility was recorded, most probably due to homogenic incompatibility. All three cultures originate from Gatineau Nat. Park, close to Ottawa.

	GB 85-1	GB 85-2	GB 273-PS	GB 345-1	GB 345-2	GB 557-1	GB 557-2	GB 565-1	GB 565-2
GB 557-1	-	-	-	-	-		+	+	-
GB 557-2	-	-	-	-	-	+		+	-
GB 565-1	±	±	-	+	+	+	+		-
GB 565-2	±	±	-	+	+	-	-	-	
GB 571-1	-	±	-	-	-	-	-	-	-
GB 571-2	-	±	-	-	-	-	-	-	-

No morphological differences between the different fruitbodies observed.

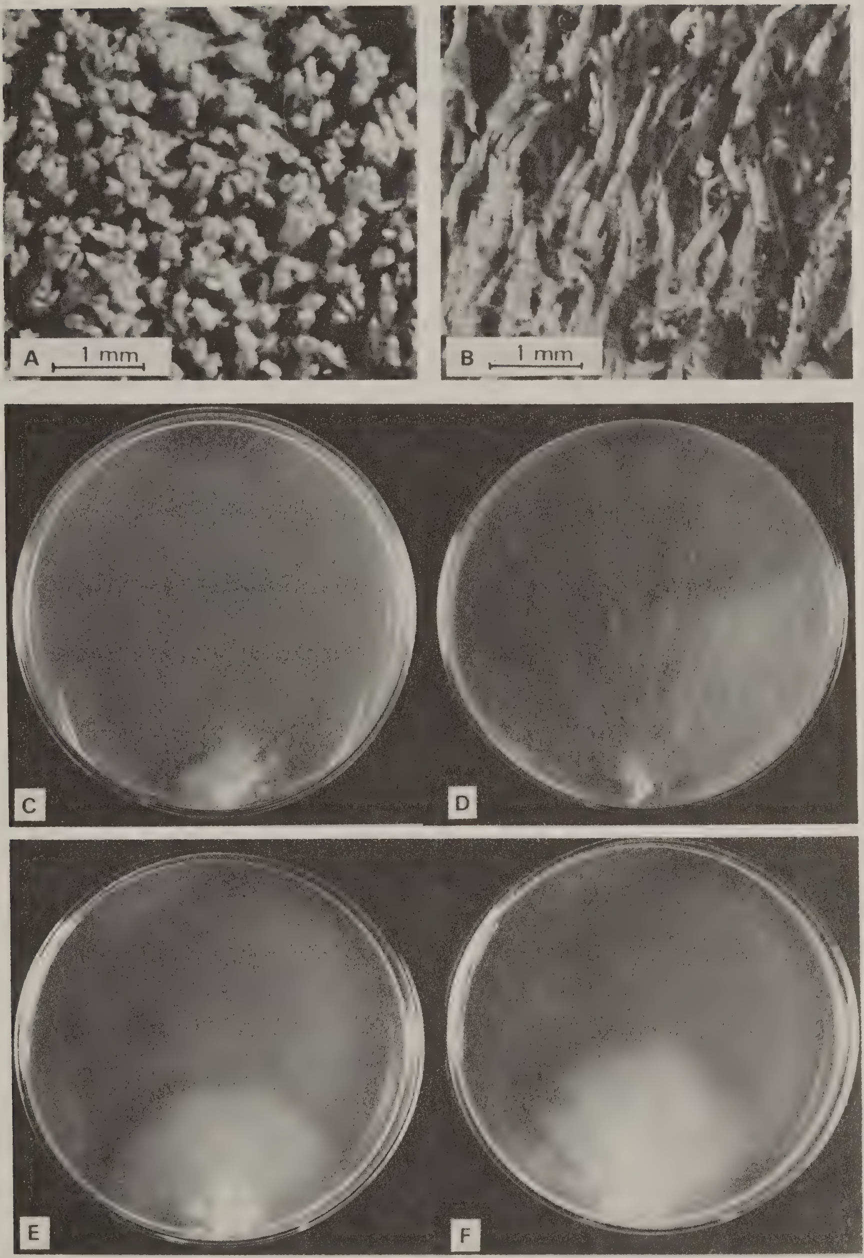


Fig. 12. Dried fruitbodies in Hyphodontia quercina, A) GB 330, B) GB 658. Cultures after six weeks growth, C) H. rimosissima, GB 273, D) do., GB 565, E) H. subalutacea, GB 650, F) do., GB 335. - Photo T. Hallingbäck.

Despite of the reduced compatibility H. rimosissima is for the moment regarded as one and the same species in Europe and N. America. Consequently, the name H. rimosissima (type from N. America) being older takes priority over H. verruculosa (type from Europe).

Apart from this species another, closely related taxon has been discerned in this study. Among the present cultures it is represented by :

GB 603/ On a fallen branch of a deciduous tree/ Canada, Quebec, Cantley/ 1/2,4 + 1 SS.

GB 603 is intersterile with the above mentioned cultures. Two herbarium specimens (NH 6240, NH 6450) also seem to belong to this taxon. It deviates from H. rimosissima by the presence of narrow hyphoid cystidioles in the hymenium and in the apices of the tubercles. These are frequently branched and incrusted - sometimes similar to dendrohyphae. Fig. 13 A.

CULTURE CHARACTERS in H. rimosissima (GB 273, GB 565):

Aerial mycelium downy. Advancing zone appressed, fringed. Hyphae with clamps, ordinarily branched, 1,5-5 µm wide; some distinctly thick-walled (GB 565); gloeocystidium-like

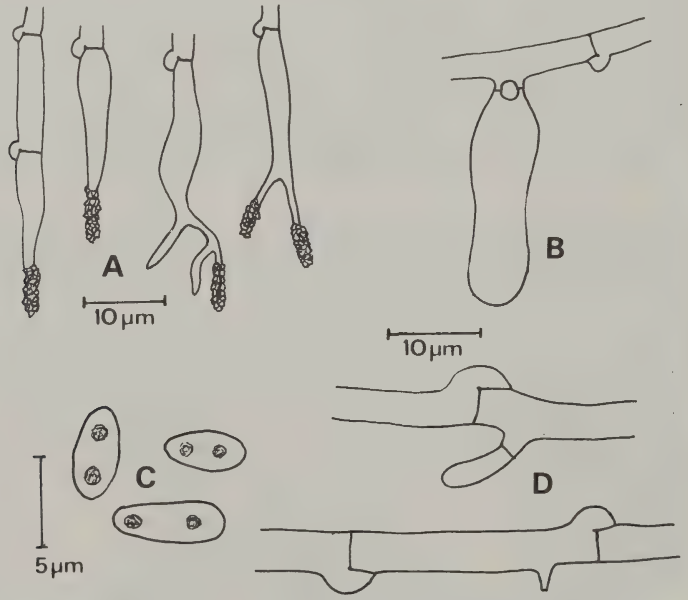


Fig. 13. A) Hyphodontia aff. rimosissima, narrow cystidioles in the hymenium, branched and unbranched, GB 603. Culture details in H. rimosissima, B) gloeocystidium, GB 273, C) conidiospores and conidiogenous hyphae, GB 565.

structures, 20-30 x 5-6,5 µm, sulfo-negative, rarely seen; in old mat rhomboidal crystals (GB 565); conidia produced singly, directly on hyphae. Slow growth in GB 273 (12 mm after 6 weeks); rapid growth in GB 565 (plate covered within 3 weeks). Figs. 12 C, D, 13 B, C.

Code:
GB 273: 2a. 2b. 3c. (7). (15b). (35). 36. 38. 47. 54. 58.
GB 565: (2a). 3c. (7). (15b). 35. 36. 38. 43. 54. 58.

Oxidase reactions:

	Syringaldazine	1-Naphtol	Gum Guaiac	Guaiacol	p-cresol	L-Tyrosin
GB 273:	+	+	+	+	-	-
GB 565:	-	-	(+)	-	-	-

Polarity: H. rimosissima is tetrapolar (Boidin and des Pomeys, 1961).

HYPHODONTIA SUBALUTACEA (Karst.) John Erikss.

Description, see Eriksson and Ryvarden (1976), p 675.

Material:
GB 96/ On burnt wood of Pinus/ Sweden, Dalarna, Töfsingdalens Nat. Park/ 6 SS.
GB 286/ On a fallen branch of Pinus/ Denmark, Jylland, Mols Bjerge/ 4 SS.
GB 299/ On a fallen branch of Quercus/ Sweden, Småland, N. Kvill Nat. Park/ 5 SS.
GB 335/ On a fallen trunk of Ulmus/ Sweden, Närke, Herrfallsäng/ 2 SS.
GB 349/ On a fallen log of a deciduous tree/ Sweden, Västmanland, Högholmsskär in Lake Mälaren/ 2 SS.
GB 650/ On a fallen, coniferous log/ Canada, B.C., Mt Seymour Prov. Park/ 1/5 + 2 SS.
GB 796/ On a fallen, coniferous log/ Canada, B.C., Vancouver Island/ 2 SS.
GB 1095/ On a fallen log of a deciduous tree/ Sweden, Västergötland, Hunneberg/ 5 SS.

In this material there are two intercompatible groups:
Group I: GB 96, GB 286, GB 650, and GB 796 - on coniferous wood.
Group II: GB 299, GB 335, GB 349, and GB 1095 - on deciduous wood.

Besides, partial compatibility between GB 650 and group II was noticed:

	GB 299-1	GB 299-2	GB 335-3	GB 335-4	GB 349-1
GB 650-1,4	-	-	-	-	-
GB 650-5	-	±	-	+	-

Within the Canadian material, GB 796 was incompatible with GB 650.

The specimens in this test seem to be morphologically uniform; the hymenium is porulose, smooth or minutely grandinioid, the spore size is 6,5-8 x 1,5-1,8(-2) µm.
Nevertheless, the compatibility tests indicate that there are two species in Europe. The specimens in group I have been collected on coniferous wood in boreal forests or other "poor" plant communities. This is the common biotop for H. subalutacea in Scandinavia (see Eriksson and Ryvarden, 1976).
The specimens in group II have been collected on wood from deciduous trees and GB 335 and GB 349 besides in "rich", herbaceous, deciduous forests with Ulmus, Fraxinus etc.
It is at the moment difficult to divide the Canadian specimens according to ecological or other parameters.
Before describing any new taxa it is necessary to carry out further intercompatibility studies to find out the ecological differences between group I and II more precisely, esp. in transitional biotopes and to find out their geographical distribution.

Several species have been described in the close vicinity to H. subalutacea viz, H. cineracea (Bourd.& Glaz.) Erikss.& Hjortst. and H. altaica Parm. (spores shorter and wider), and H. floccosa (Bourd. & Galz.) John Erikss. (fruitbody floccose - odontioid). The latter species have been proved to be intersterile with H. subalutacea (Faisal, 1981).

CULTURE CHARACTERS in H. subalutacea (GB 335, GB 650):

Aerial mycelium absent. Advancing zone even, appressed. Hyphae with clamps, ordinarily branched, 1,5-3,5 µm wide, richly branched in old mat, more sparsely towards the margin; small globose to cylindrical structures with a little peg on the top, scattered direct on hyphae (GB 650). Slow growth, after 6 weeks only ca 20 mm. Figs. 12 E, F, 9 B.

Code:
GB 335: 2a. 2b. 3c. 7. 32. 36. 38. 47. 54. 58.
GB 650: 2a. 2b. 3c. (7). (26). 32. 36. 38. 47. 55. 60.

Oxidase reactions:

	Syringaldazine	1-Naphtol	Gum Guaiac	Guaiacol	p-cresol	L-Tyrosin
GB 335:	-	+	-	-	-	+
GB 650:	-	+		-	-	+

Polarity: H. subalutacea is tetrapolar (Faisal 1981).

HYPOCHNICIUM BOMBYCINUM (Sommerf.:Fr.)John Erikss., H. KARSTENII (Bres.)Hallenb., and H. LUNDELLII (Bourd.)John Erikss.

These are three very closely related species, differing mainly in the size and shape of spores. Hallenberg (1983) segregated H. karstenii from H. bombycinum and N. European specimens of both species were shown to be intersteri-

le. In the present study new material confirms intersterility between these species.
In several Canadian collections, presumably SS-cultures produced clamps. After neohaploidization, however, stable haploid cultures were obtained and these were used in the tests.

H. BOMBYCINUM (Sommerf.:Fr.)John Erikss.

Description, see Eriksson and Ryvarden (1976), p 697 and Hallenberg (1983).

Material:
GB 37/ Sweden, Västergötland, Göteborg, Botanical Garden/3 SS.
GB 253/ On a leaning log of Salix/ Sweden, Torne Lappmark, Abisko/2 SS.
GB 763/ On a dead standing tree of Fagus/ Canada, Ontario, Algonquin Prov. Park/ 4 isolated SS which all were clamped.

Compatibility between these specimens. Di-mon tests between GB 763 and the haploids of GB 37 and GB 253 were all compatible. Neohaplonts of GB 763 were tested with GB 37 and GB 253 haploids with the same result. These three specimens were incompatible with haploids of H. karstenii.
GB 37, GB 253, and GB 763 are morphologically uniform and fit the descriptions cited above.

Culture characters, see Hallenberg (1983).

H. KARSTENII (Bres.)Hallenb.

Descriptions, see Eriksson and Ryvarden (1976), p 697 (under H. bombycinum) and Hallenberg (1983).

Material:
GB 66/ On a leaning log of Pinus/ Denmark, Jylland, Mols Bjerge/ 1/2; 4/3,5.
GB 79/ On a fallen trunk of Picea abies/ Sweden, Östergötland, Omberg/ 8 SS.
GB 749/ On a fallen branch of a deciduous tree/ Canada, Ontario, Algonquin Prov. Park/ 4 isolated SS, all clamped. Neohaplonts (GB 872) used in the tests.
GB 778/ On a fallen branch of a deciduous tree/ Canada, Quebec, Cantley/ 1,4/2,3.

Morphoplogically, the N. European and Canadian specimens are distinct and the features within each group are uniform. The Canadian specimens differ from the European ones by a slightly denser context, smaller spores (7-8 x 5-6 µm versus 7-10 x 6,5-9,5 µm) and slightly more narrow basidia (6-7 µm versus 6-8 µm).
Partial compatibility between European and N. American specimens according to the following ("e" means unilateral dicaryotization):

	GB 66-1	GB 66-2	GB 79-1	GB 79-2	GB 778-1	GB 778-2	GB 872-1	GB 872-2
GB 66-1		+	+	+	+	-	$+^{e}$	$+^{e}$
GB 66-2	+		+	+	+	-	$+^{e}$	$+^{e}$
GB 79-1	+	+		-	+	-	-	-
GB 79-2	+	+	-		$+^{e}$	-	-	-
GB 778-1	+	+	+	$+^{e}$		+	+	+
GB 778-2	-	-	-	-	+		+	+

Culture characters, see Hallenberg (1983).

H. LUNDELLII (Bourd.)John Erikss.

Description, see Eriksson and Ryvarden (1976), p 713.

Material:
GB 822/ On a dead stem of Typha latifolia/ Sweden, Halland, Tjolöholm/ 5 isolated SS, all clamped.

Neohaplonts were used in the tests. They were intersterile with available cultures of *H. bombycinum* and *H. karstenii*.
The spores in GB 822 are uninucleate.

HYPOCHNICIUM GEOGENIUM (Bres.)John Erikss.

Description, see Eriksson and Ryvarden (1976), p 711.

Material:
GB 416/ On a fallen trunk of Alnus/ Austria, Steiermark, Schwanberg/ 5 isolated SS, all clamped.
GB 769/ On a fallen log of Pinus strobus/ Canada, Quebec, Cantley/ 3 isolated SS, all clamped. Neohaplonts were used in the compatibility tests.
GB 814/ On a fallen log of Abies balsamea/ Canada, Quebec, Cantley/ 2,3/4.

Compatibility existed between GB 416, GB 769, and GB 814. No noticeable morphological differences between the fruitbodies were found.

MERULIUS TREMELLOSUS Fr.

Description, see Eriksson and Ryvarden (1976), p 865.

Material:
GB 519/ On a fallen branch of Fraxinus excelsior/ Sweden, Västergötland, V. Tunhem/1,3,6,7,8,9/2,4,5.
GB 617/ On a fallen log of Betula/ Canada, Ontario, Shaw Woods Preserve, 80 km E. of Ottawa/ 1 PS.

Compatibility between GB 519 and GB 617. No noticeable morphological differences observed between the fruitbodies.
Polarity: M. tremellosus is bipolar (Tassinari 1956, Ginns 1976).

METULODONTIA NIVEA (Karst.)Parm.

Description, see Eriksson and Ryvarden (1976), p 871.

Material:
GB 323/ On wood from a deciduous tree/ Sweden, Närke, Herrfallsäng/ 4 SS.
GB 353/ On Picea/ Sweden, Uppland, N. Varleda/ 1/4; 3/2,4,5.
GB 576/ On a fallen log of Populus grandidentata/ Canada, Quebec, Gatineau Nat. Park/1,2/4 + 1 SS.
GB 752/ On a fallen log of Ostrya/ Canada, Ontario, Algonquin Prov. Park/ 2,3/4.

Compatibility between these specimens. The morphology of their fruitbodies corresponds with the description mentioned above. There is, however, variation in the number of encrusted cystidia (also observed between additional Nordic herbarium specimens). In the material studied here, the Swedish specimens have few encrusted cystidia while the Canadian ones have abundant and even projecting cystidia.
Sulfovanilline did not stain subulate hymenial cystidia in any of the above mentioned specimens.
Polarity: M. nivea is tetrapolar (Boidin and Lanquetin, 1965).

PENIOPHORA INCARNATA (Fr.)Karst.

Description, see Eriksson et al (1978), p 927.

Material:
GB 43/ On a fallen branch of Quercus/ Sweden, Skåne, Hallands Väderö/ 1/7; 3/9.
GB 712/ On a fallen branch of a deciduous tree/ Canada, B.C., Vancouver/ 2/3; 1,4/ .
GB 728/ On a fallen twig of a deciduous tree/ Canada, B.C., Squamish/ 2 SS.
GB 924/ On a coniferous fence/ Scotland, Perthshire, Kindrogan Field Sta/ 1/2 .
GB 1020/ On a fallen branch of a deciduous tree/ Romania, Distr. Iasi, Repedea forest close to Iasi/ 5 SS.

Compatibility existed between GB 43, GB 712, GB 728, GB 924, and GB 1020. The fruitbodies are morphologically uniform, except the colour in GB 712 (when live) was brownish instead of reddish.
Polarity: P. incarnata is tetrapolar (Biggs 1938).

PENIOPHORA NUDA (Fr.)Bres. and P. VIOLACEOLIVIDA (Sommerf.) Mass.

Descriptions, see Eriksson et al (1978), p 953 and 985 resp.

Material of P. nuda:
GB 51/ On a fallen branch of Fraxinus/ Sweden, Skåne, Hallands Väderö/ 3 SS.
GB 212/ On Prunus spinosa/ Sweden, Skåne, Kullaberg/ 3/1,2.
GB 448/ On Populus tremula/ Sweden, Västergötland/ 9/1,2,10; 11/3,6.

Material of P. violaceolivida:
GB 213/ On a fallen branch of Alnus glutinosa/ Sweden, Västergötland, Göteborg Botanic Garden/ 4 SS.
GB 594/ On a fallen branch of a deciduous tree/ Canada, Quebec, Cantley/ 4 SS.
GB 596/ On a fallen branch of Ostrya/ Canada, Quebec, Cantley/ 1/2.
GB 772/ On a fallen branch of Ostrya/ Canada, Ontario, South March village near Ottawa/ 3 SS.

The cultures of P. nuda were compatible, those of P. violaceolivida were as well compatible. All matings between the two species were negative.
It is often a difficult problem, how to correctly determine specimens in this group. Fruitbodies of the specimens involved in this test were examined carefully. The morphological differences in sulfocystidia between the two species agreed with the descriptions mentioned above.
In P. nuda, the sulfocystidia are numerous in the basal layer, have a wide, rounded apex and are 9-15 µm across. In P. violaceolivida, the sulfocystidia vary in number, most are distinctly elongated and 7-12 µm wide. However, in GB 448 there are numerous elongated sulfocystidia except for the wide, rounded ones in the basal layer. Eriksson and Hallingbäck (1979) found that a specimen having some elongated sulfocystidia like those in P. violaceolivida was compatible with a "normal" P. nuda. Obviously there exist specimens in this complex which cannot be determined correctly on morphology alone. The spores (when measured from spore-prints) are slightly larger in P. nuda, 8-10,5 x 3-3,5 µm, versus 7-9 x 2,3-3 µm in P. violaceolivida. The difference in some specimens is too small to be of value in separating the species.

Polarity: Both P. nuda and P. violaceolivida are tetrapolar (Eriksson 1950, Tassinari 1956).

PENIOPHORA POLYGONIA (Fr.)Bourd.& Galz.

Description, see Eriksson et al (1978), p 965.

Material:
GB 232/ On a leaning log of Populus/ Denmark, Jylland, Mols Bjerge/ 3 SS.
GB 765/ On a fallen branch of Populus/ Canada, Ontario, Algonquin Prov. Park/ 2 SS.
GB 893/ On a fallen branch of a deciduous tree/ Denmark, Jylland, Rold Skov S of Ålborg/ 5 SS.

Compatibility existed between GB 232, GB 765, and GB 893. No noticeable differences in fruitbody morphology observed. Polarity: P. polygonia is tetrapolar (Boidin 1961).

PHLEBIA CENTRIFUGA Karst.

Description, see Eriksson et al (1981), p 1093.

Material:
GB 136/ On a fallen trunk of Picea/ Sweden, Dalarna, Njupeskär/ 1,2,4/3.
GB 762/ On a fallen log of yellow birch/ Canada, Ontario, Algonquin Prov. Park/ 2 SS.
GB 1013/ On a fallen trunk of Picea/ Romania, Distr. Suceava, forest reserve "Poiana Stampei"/ 1 PS.

Compatibility existed between GB 136, GB 762, and GB 1013. In an earlier study Hallenberg (1981) showed that two other Canadian collections of P. centrifuga from Ontario were compatible with GB 136.
In Europe, P. centrifuga is normally found on fallen trunks of Picea in virgin forests. The fruitbodies are mostly large, papillose and irregularly wrinkled.
The Canadian specimens are collected on both coniferous and deciduous wood, their fruitbodies being smaller and frequently radially folded.

PHLEBIA RADIATA Fr.

Descriptions, see Eriksson et al (1981), p 1153.

Material:
GB 376/ On a fallen log of Prunus/ Austria, Steiermark, Graz/ 1,2/3,4,5.
GB 383/ On a fallen log of Fagus/ Austria, Steiermark, W. of Schwanberg, 1250 m.s.m./ 3 SS.
GB 713/ On a fallen branch of a deciduous tree/ Canada, B.C., Vancouver/ 1 PS.
GB 1024/ On a fallen trunk of Fagus/ Romania, Distr. Suceava, Codrul Secular Slatioara/ 5 SS.

Compatibility between these specimens. Morphologically, GB 376 deviates by having a dark violaceous fruitbody, except for the margin which is reddish. In the microstructure they are all uniform.
Polarity: P. radiata is bipolar (Tassinari 1956, Nobles et al 1957, Ginns 1976).

PHLEBIA RUFA (Fr.) M.P. Christ.

Description, see Eriksson et al (1981), p 1157.

Material:
GB 144/ Denmark, Mön, Fanefjord Skov/ 1 SS, 1 PS.
GB 208/ On wood of Fagus/ Sweden, Östergötland, Omberg/ 1,3,4,5,6/8.
GB 257/ On a leaning log of Fagus/ Denmark, Jylland, Mols Bjerge/ 1 PS.
GB 313/ On a leaning log of Quercus/ Sweden, Västmanland, Högholmsskär/ 5 SS.
GB 705/ On a fallen branch of Alnus/ Canada, B.C., Vancouver Island/ 1/3.
GB 755/ On a fallen log of a deciduous tree/ Canada, Ontario, Algonquin Prov. Park/ 2 PS.
GB 1041/ On a fallen branch of a deciduous tree/ Romania, Distr. Harghita, near Toplita/ 1 PS.

Compatibility existed between the above mentioned specimens. In microstructure, there is expected some natural variation in the frequency of embedded gloeocystidia. Such variation is observed in the material cited.
In macrostructure, there is a variation in the colour of the fruitbodies as well as in the development of the meruloid structure of the hymenium. GB 755 was whitish as live and became brownish after drying. The fruitbodies in GB 208 and GB 313 are young and covering old fructifications of P. rufa, their hymenia being smooth (even after drying) and light ochraceous. Fig. 14 A, B, D.
Polarity: According to Boidin (1964) and others P. rufa is bipolar.

There are two specimens from Canada, which morphologically are very close to P. rufa but intersterile with the above mentioned cultures:

GB 553/ On a fallen log of Acer/ Canada, Quebec, Gatineau Nat. Park/ 3 SS.
GB 568/ On a hanging branch of Acer/ Canada, Quebec, Gatineau Nat. Park/ 1 PS.

GB 553 is compatible with GB 568 (di-mon matings).
They deviate from P. rufa by having reflexed fruitbodies and a determinate margin. Besides, the embedded gloeocystidia frequently appear to have spiral thickenings (Figs. 14 C, 15 A). As the natural variation within P. rufa still is not fully understood it is difficult to point out additional distinct separating characters. At the moment these two cultures are labelled Phlebia aff. rufa.

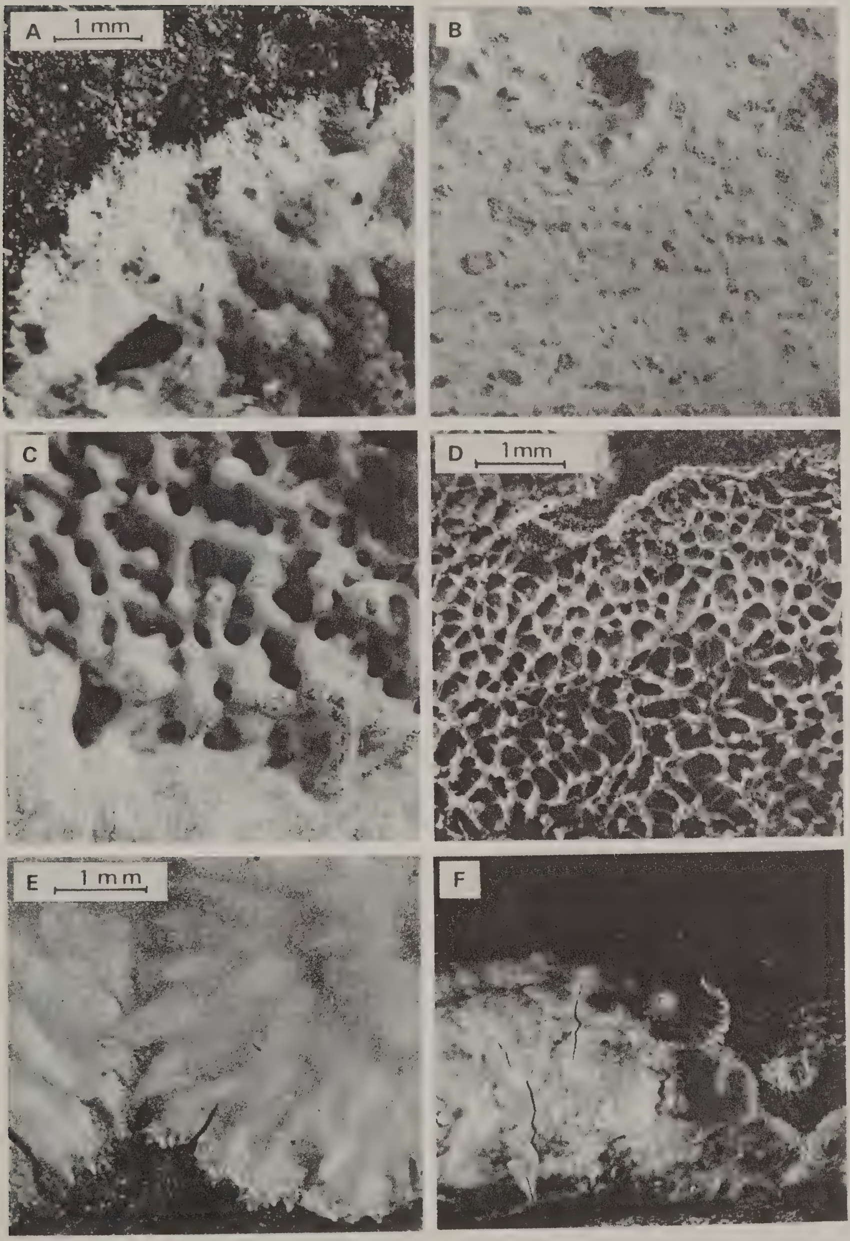


Fig. 14. Dried fruitbodies, A) Phlebia rufa, GB 755, B) do., GB 313, C) P. aff. rufa, GB 553, D) P. rufa, GB 1041. Soaked fruitbody of Radulomyces confluens, E - F) GB 733. - Photo T. Hallingbäck.

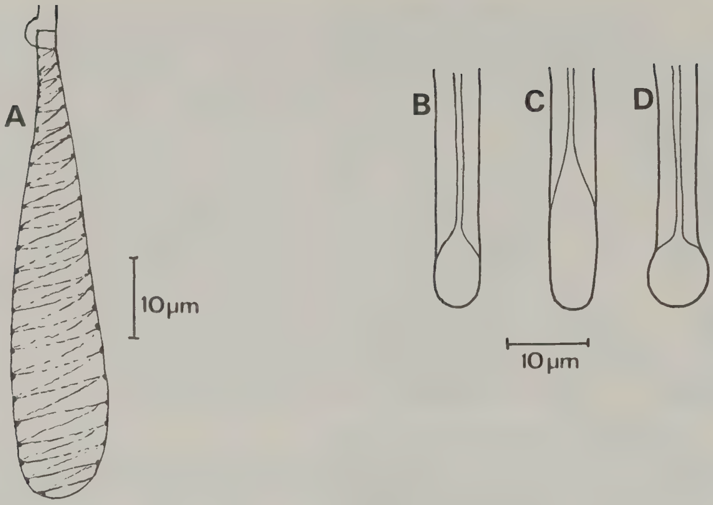


Fig. 15. A) *Phlebia* aff. *rufa*, embedded cystidia with spiral thickenings, GB 553. *Tubulicrinis borealis*, variation in apices of cystidia, B) GB 339, C) GB 439, D) GB 795.

PHLEBIA SUBOCHRACEA (Bres.) Erikss. & Ryv.

Descriptions, see Eriksson et al (1981), p 1169; Nakasone et al (1982).

Material:
GB 774/ On a fallen branch of Ulmus/ Canada, Ontario, South March village W. of Ottawa/ 1 PS.
GB 819/ On a fallen branch of a deciduous tree/ Denmark, Sjaelland, Allindelille / 1,3,5/2,4,6.
HHB 8494/ On Quercus arizonica/ USA, Arizona, Coronado Nat. Forest, Santa Cruz/ 1/2.

Fructifications in culture were obtained from PS-cultures of each specimen and after spore dispersal new SS-cultures were isolated. Compatible mating types of each specimen were used in intercompatibility tests which resulted in compatibility between GB 774 and HHB 8494. These two were incompatible with GB 819.

No noticeable differences in morphology between the fruitbodies.
Polarity: *P. subochracea* is bipolar (Nakasone et al, 1982).

RADULOMYCES CONFLUENS (Fr.)M.P. Christ.

Description, see Eriksson et al (1981), p 1239.

Material:
GB 74/ On a fallen branch of Sambucus/ Denmark, Jylland, Mols Bjerge/ 1,7,9,10/3,8 + 3 SS.
GB 733/ On a fallen branch of Alnus/ Canada, Ontario, Algonquin Prov. Park/ 1/2.
GB 1071/ On a fallen branch of a deciduous tree/ Romania, Distr. Bistrita-Nasaud, W of Bistrita/ 6 SS.

Compatibility between GB 74, GB 733, and GB 1071. No noticeable micromorphological differences observed but the fruitbody in GB 733 is provided with blunt, scattered tubercles, while the Danish collection is smooth as dry. Fig. 14 E, F.
Polarity: R. confluens is tetrapolar (Boidin and Lanquetin, 1965).

RESINICIUM BICOLOR (Fr.)Parm.

Description, see Eriksson et al (1981), p 1265.

Material:
GB 46/ On a fallen, coniferous log/ Sweden, Skåne, Hallands Väderö/ 1,3,4/2 + 1 SS.
GB 391/ On a fallen log of Abies alba/ Austria, Steiermark, Mt Schökel/ 1,2/3.
GB 683/ On a fallen log of Pseudotsuga menziesii/ Canada, B.C., Vancouver Island/ 1,2,3/4.
GB 927/ On a fallen trunk of Sequoiodendron/ Scotland, Perthshire, Kindrogan Field Sta./ 1/2 .
GB 1026/ On a fallen log of Picea/ Romania, Distr. Bistrita-Nasaud, E. of Bistrita/ 5 SS.

Compatibility between the European specimens. When these cultures were mated with GB 683-1,2 (Canada), clamps were produced, but when mated with GB 683-4 no clamps were seen.

In fruitbody morphology there is a variation (obviously intraspecific) in the length of the teeth. The Canadian specimen, as well as several herbarium collections from the Vancouver area, differs from the European ones by shorter spores (in GB 683: 4,5-5,5 µm long; in GB 46: 6-7,5 µm long, when measured from spore-prints).
Polarity: R. bicolor is bipolar (Boidin and Lanquetin, 1965).

RESINICIUM FURFURACEUM (Bres.)Parm.

Description, see Eriksson et al (1981), p 1269.

Material:
GB 108/ On a fallen, brown-rotted log of Pinus/ Sweden, Dalarna, Töfsingdalen Nat. Park/ 1,3/4,6 + 2 SS.

GB 113/ collecting data as above/ 5 SS.
GB 119/ collecting data as above/ 6 SS.
GB 121/ On a fallen branch of Pinus/ locality as above/ 3,5,6/4 + 2 SS.
GB 378/ On a stump/ Austria, Steiermark, St. Radegund/ 1/2 + 3 SS.
GB 492/ On a fallen log of Abies lasiocarpa/ Canada, B.C., Yoho Nat. Park/ 1,6/2,3,4,5,7.
GB 590/ On a fallen trunk of Pinus strobus/ Canada, Quebec, Cantley/ 3/4,7; 2,5/6.
GB 644/ On a fallen, coniferous log/ Canada, B.C., Vancouver/ 3 SS.

Compatibility between most of these specimens. A few cases with partial compatibility were noted:

		Austria		Canada			
		GB 378-1	GB 378-2	GB 492-1	GB 492-2	GB 590-3	GB 590-4
Sweden	GB 108-1	+	+	+	+	+	-
	GB 108-4	-	-	+	+	+	±
	GB 121-3	+	+	+	+	+	±
	GB 121-4	+	+	+	+	+	±
Can.	GB 644-1	+	+	-	+	+	+

No noticeable morphological differences between the fruitbodies.

SISTOTREMASTRUM NIVEOCREMEUM (Höhn. & Litsch.)John Erikss.

Description, see Eriksson et al (1984).

Material:
GB 158/ On a fallen twig of Fagus/ Denmark, Lolland/ 12 isolated SS, all clamped.
GB 248/ On a fallen branch of Betula/ Sweden, Torne Lappmark, Abisko Nat. Park/ 6 isolated SS, all clamped.
GB 367/ On a deal on the ground/ Austria, Steiermark, Hohenberg near Graz/ 2,3/4,5 + 1 SS.
GB 531/ On a fallen log of yellow birch/ Canada, Quebec, Cantley/ 1/2 + 1 SS.
GB 729/ On a fallen branch of Alnus rubra/ Canada, B.C.,Squamish/ 4 isolated SS, all clamped.
GB 748/ On a fallen log of Abies balsamea/ Canada, Ontario, Algonquin Prov. Park/ 1/3 + 1 SS.
GB 845/ On a fallen branch/ Sweden, Västergötland, Göteborg Botanical Garden/ 10 isolated SS, all clamped.

Only two of the above mentioned specimens were intercompatible, viz. GB 531 and GB 748. Homothallism is indicated for GB 158, GB 248, GB 729, and GB 845 as isolated SS-cultures were clamped. Besides, arthrospores from these cultures were dispersed on malt agar plates and all isolated germlings were clamped.

Morphologically, the European specimens are rather uniform with exception for GB 845. This specimen deviates by having larger spores, 8,5-11 x 3,5-4,5 µm (compared with 6-9 x 2,5-3 µm, in Eriksson et al, 1984) which are binucleate. Besides, the number of sterigmata is reduced in many basidia, thus varying between 2 and 6. It seems like GB 845 is (or mimics) an amphithallic variety (larger spores, occurrence of 2-sterigmate basidia).
Among the Canadian material, GB 729 is similar to the European collections mentioned here, while GB 531 and GB 748 deviate by having a thicker fruitbody, with more prominent rhizomorphs (instead of simple strands in the European material) and a tendency to form tubercles on the hymenial surface. Further the Canadian specimens have sub-membranaceous, sub-pellicular fruitbodies with continous hymenia which do not seem to thicken as much as in the European material. Thus, the hymenium is composed of basidial clusters that have grown together. Fig. 16 A, B, C.

CULTURE CHARACTERS in S. niveocremeum (GB 158, GB 367, GB 729, GB 748, GB 845):

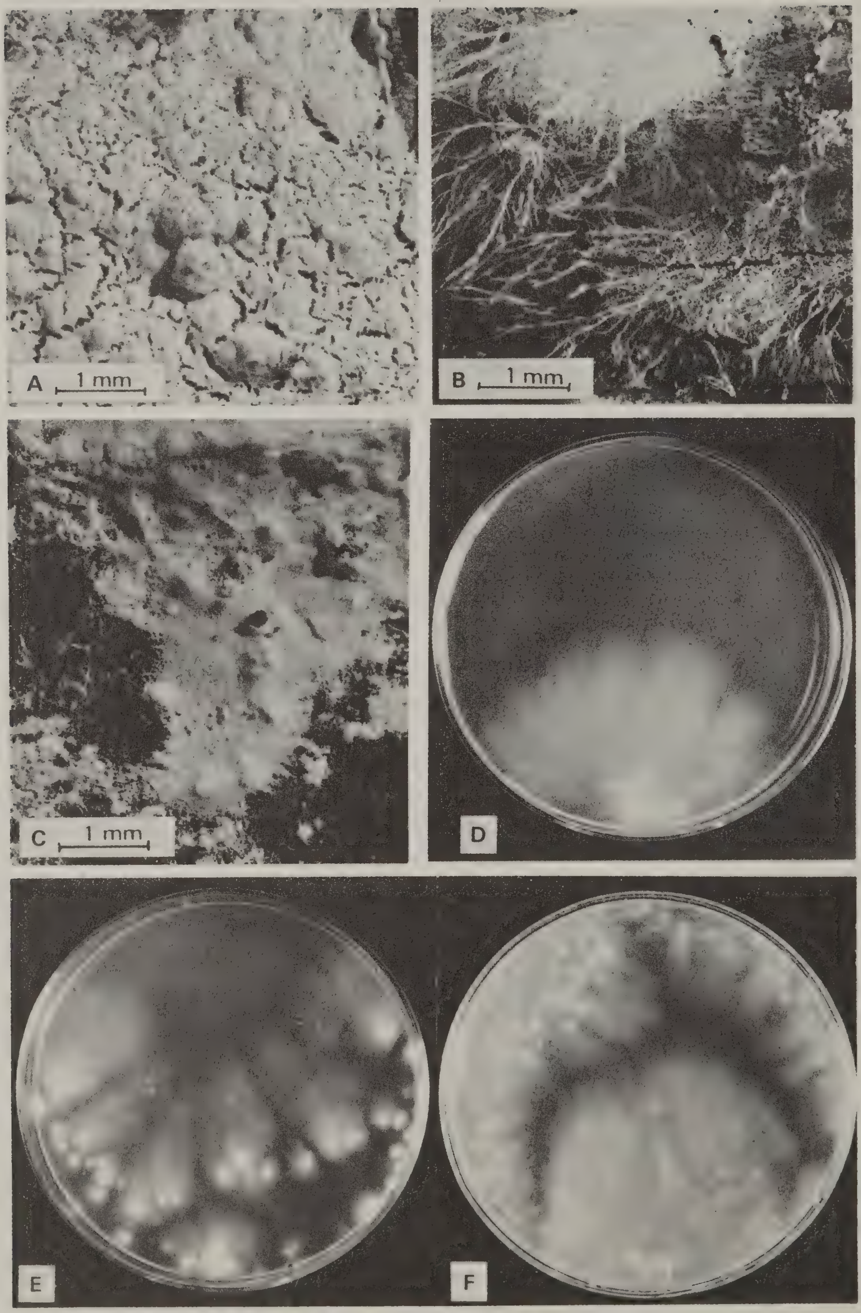
Aerial mycelium downy; floccose (GB 158, GB 729); scattered subcultures arise due to dispersal of arthroconidia (GB 367). Advancing zone appressed; even (GB 367, GB 845); fringed (GB 158, GB 729, GB 748). Hyphae slightly thick-walled, ordinarily branched, with clamps, 1,5-5 µm wide, partly with oilrich contents; narrow hyphae richly and irregularly branched (GB 367); some capitate hyphal endings (GB 367); cylindrical arthroconidia produced in tufts (GB 158, GB 367, GB 729, GB 748). Figs. 16 D, E, F, 17 A, B.

Code:
GB 158: 2a. 2b. 3c. 7. 35. 36. 38. 47 (60 mm). 54. 57.
GB 367: 2a. 3c. 11. (26.) 35. 36. 38. 45. 55. 58.
GB 729: 2a. 2b. 3c. 7. 35. 36. 38. 47 (30 mm). 54. 57.
GB 748: 2a. 3c. 7. 35. 36. 38. 45. 55. 58.
GB 845: 2a. 2b. 3c. 7. 32. 36. 38. 47 (30 mm). 54. 57.

Oxidase tests:

	Syringaldazine	1-Naphtol	Gum Guaiac	Guaiacol	p-cresol	L-Tyrosin
GB 158:	+	+	+	+	−	+
GB 367:	+	+	+	+	−	−
GB 729:	+	+	+	+	−	+
GB 748:	+	+	+	+	−	−
GB 845:	+	+	+	+	−	+

Cytology: Spores were uninucleate in GB 248, GB 531, GB 729, and GB 748; in GB 845 both uninucleate and binucleate spores were seen (amphithallism indicated).


A 1 mm
B 1 mm
C 1 mm
D
E
F

TUBULICRINIS BOREALIS John Erikss.

Description, see Hjortstam (1979).

Material:
GB 339/ On a fallen log of Picea/ Sweden, Närke, Herrfallsäng/4 SS.
GB 439/ Sweden, Västergötland, Alingsås/ 1/4.
GB 795/ On a fallen log of Pseudotsuga menziesii/ Canada, B.C., Vancouver Island/ 4 SS.

Compatibility between GB 339 and GB 439, GB 795. No clamps were seen in the crossings between GB 439 and GB 795 even after having been in contact with each other for more than two months, but the growth was extremely slow.
There is a variation in the shape of apices of cystidia between the specimens (Fig. 15 B-D). In GB 339 they are typically obtuse, not or slightly widened, capillary lumen ending abruptly. In GB 439 the thin-walled apical part is prolonged and the capillary lumen is not in all cases ending abruptly; in many cases ending rather gradually. In GB 795 the cystidia are frequently capitate, capillary lumen ending abruptly.
The spores, when measured from spore-prints, are uniform in size and shape in these three collections (5,5-7 x 2,3-2,5 µm).

TUBULICRINIS GLEBULOSUS (Bres.)Donk

Description, see Hjortstam (1979).

Material:
GB 285/ On a fallen branch of Betula/ Sweden, Torne Lappmark, Abisko Nat. Park/ 1,4,5/2,6.
GB 787/ On a fallen twig of Populus/ Canada, Quebec, Gatineau Nat. Park/ 2/3.

Compatibility between the two specimens. No noticeable morphological differences between the fruitbodies.

TUBULICRINIS SUBULATUS (Bourd.& Galz.)Donk

Description, see Hjortstam (1979).

Material:
GB 288/ On a fallen log of Picea/ Denmark, Jylland, Mols Bjerge/ 1,3,6,7/2,4,5
GB 363/ On Populus/ Sweden, Uppland, N. Varleda/ 3/5.
GB 540/ On a fallen log of Abies balsamea/Canada, Quebec, Cantley/ 1/2,3 + 1 SS.

Fig. 16. Sistotremastrum niveocremeum, dried fruitbodies, A) GB 729, B) GB 531, C) GB 367. Cultures after six weeks growth, D) GB 845, E) GB 729, F) GB 367. - Photo T. Hallingbäck.

The cultures grew very slowly but clamps formed on the confrontation line between GB 288 and GB 363; the Canadian collection was intersterile with the N. European ones.
There are no conspicuous morphological differences between the specimens, however, the cystidia in GB 540 are somewhat less amyloid than in GB 288 and GB 363.

XENASMATELLA FILICINA (Bourd.)Oberw.

Description, see Oberwinkler (1965).

Material:
GB 47/ On a fallen, coniferous log/ Sweden, Skåne, Hallands Väderö/ 1,2,4/3,5,7 + 3 SS.
GB 216/ On a fallen branch of Pinus/Sweden, Halland, Särö Västerskog/ 3 SS isolated, 2 of them were clamped.
GB 223/ On a fallen branch of Pinus/ Sweden, Halland, Särö Västerskog/ 7 isolated SS, all clamped. This specimen fruited in culture and isolated SS-mycelia (GB 361) were haploid. Compatible mating types of these were used in intercompatibility tests.
GB 396/ On a fallen branch of a deciduous tree/ Austria, Steiermark, Schwanberg/ 2 SS.
GB 541/ On a fallen log of Abies balsamea/ Canada, Quebec, Cantley/ 1 SS.
GB 647/ On a fallen, coniferous log/ Canada, B.C., Mt Seymour Prov. Park/ 1 SS.
GB 725/ On a fallen, coniferous log/ / Canada, B.C., Garibaldi Prov. Park/ 2 SS.

GB 216 and GB 647 were incompatible with most other cultures:

	GB 47-1	GB 47-3	GB 216-2	GB 361-1	GB 361-5	GB 396-4	GB 396-5	GB 541-1	GB 647-1	GB 725-2	GB 725-4
GB 216-2	-	-		-	-	+	-	-	±	-	±
GB 647-1	-	-	±	-	-	+	-	+		-	-

Compatibility between GB 47, GB 361, GB 396, GB 541, and GB 725, except for incompatibility in the combinations GB 47-3,8 x GB 361-1.

Within the big group of compatible specimens there are no noticeable morpholigical differences. GB 216, however, deviates clearly by having narrower spores (6,5-7 x 2,8-3,5 µm versus, in X. filicina, 6-8,5 x 3,5-5 µm). Thus, GB 216 comes very close to X. filicina var. in Oberwinkler (1965) and is so named. Fig. 18 A, B.

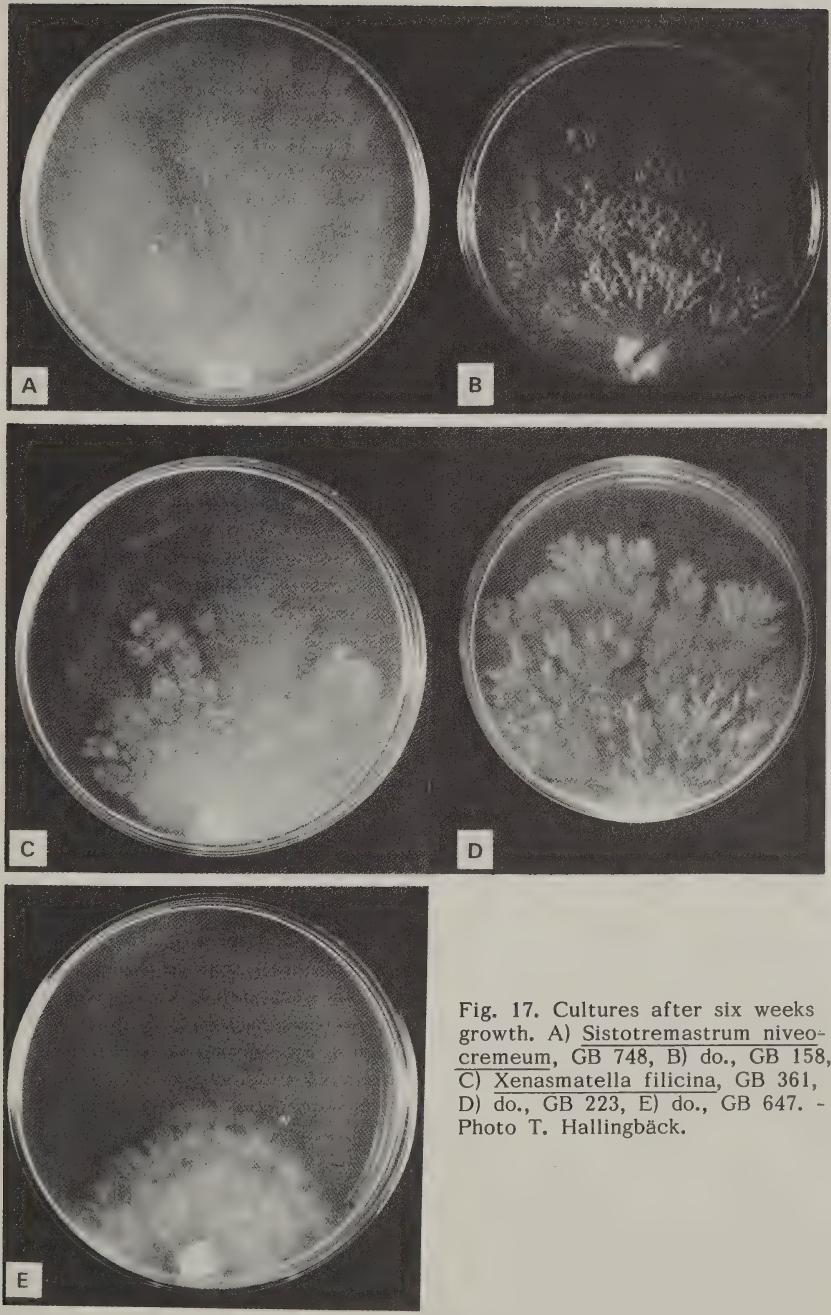


Fig. 17. Cultures after six weeks growth. A) *Sistotremastrum niveocremeum*, GB 748, B) do., GB 158, C) *Xenasmatella filicina*, GB 361, D) do., GB 223, E) do., GB 647. - Photo T. Hallingbäck.

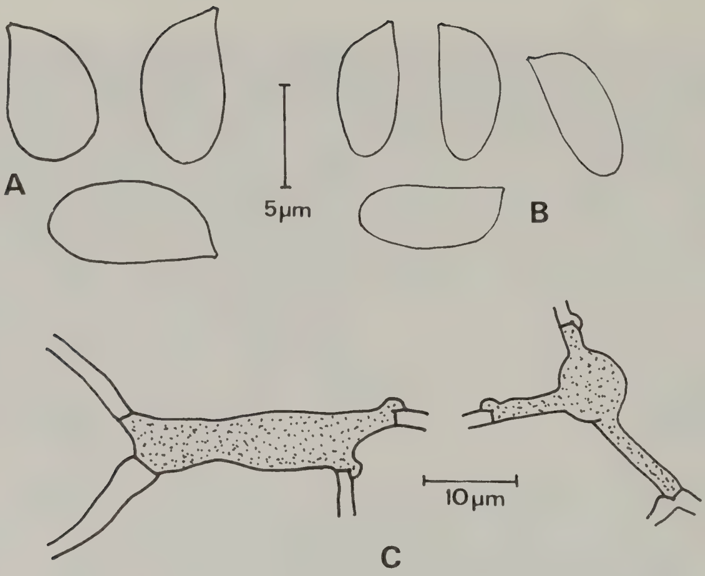


Fig. 18. Spores in A) Xenasmatella filicina, GB 47, B) X. filcina var., GB 216. Culture details, C) X. filicina, irregular inflations on hyphae, GB 647.

CULTURE CHARACTERS X. filicina (GB 223, GB 361, GB 647):

Aerial mycelium downy; plumose (GB 223, GB 647); Advancing zone appressed, fringed, bayed; Hyphae with clamps at some septa, partly oil-rich, 1,5-5 µm wide, irregular inflations of hyphae (Figs. 18 C, 17 C, D, E).

Code:
GB 223: 1. 3i. 26. 32. 36. 38. 46. 48. 55. (57). (64).
GB 361: 1. 3i. 26. 32. 36. 38. 47 (50 mm). 58. 61.
GB 647: 1. 3i. 26. 32. 36. 38. 47 (25 mm). 55. 58.

Oxidase reactions: All tests were negative.

Cytology: Spores are uninucleate, SS-cultures are monocaryotic, PS-cultures dicaryotic.

EARLIER STUDIES ON COMPATIBILITY BETWEEN SPECIMENS FROM DIFFERENT CONTINENTS.

Intercompatibility in species belonging to the fungus flora of the boreal or nemoral zone in the N. hemisphere:

Species / Origin of cultures/ References/

Aleurodiscus lividocoeruleus (Karst.)Lemke / France, Canada/ Boidin et al (1968),

Basidioradulum radula (Fr.)Nobles / France, Canada / Nobles (1967),

Chondrostereum purpureum (Fr.)Pouz. / Norway, Canada / Robak (1942),

Dichostereum effuscatum (Cke & Ellis) Boid.& Lanq. / France, Canada, Argentina / Lanquetin (1973 a).

Dichostereum sordulentum (Cke & Mass.) Boid. & Lanq. / USA (Georgia, Louisiana), partial compatible with D. durum (Bourd. & Galz.)Pil. /France/ Boidin and Lanquetin (1980), Lanquetin and Boidin (1983).

Hyphoderma mutatum (Peck)Donk / France, Canada, only compatibility with group B sensu Mc Keen (1952) / Boidin and des Pomeys (1961),

Laxitextum bicolor (Fr.)Lentz / group A, sensu Boidin (1977): Germany, France, Canada, USA (Louisiana), India; group B: Germany, France, USA (Louisiana) / Boidin (1977),

Peniophora incarnata (Fr.)Karst. / France, England, Canada, Iran / Boidin and des Pomeys (1961), Hallenberg (1981 a),

Peniophora piceae (Pers.) John Erikss. / France, Canada / Boidin and des Pomeys (1961),

Peniophora pini (Fr.)Boid. / Partial compatibility between ssp. pini Weres. & Gibson from France and ssp. duplex Weres. & Gibson from Canada / Weresub and Gibson (1960),

Peniophora pithya (Pers.)John Erikss. / France, Canada / Boidin and des Pomeys (1961),

Peniophora polygonia (Fr.) Bourd. & Galz. / France, Canada / Boidin and des Pomeys (1961),

Phaeophlebia strigosozonata (Schw.)Talbot / Siberia, Central African republic / Boidin (1977),

Phlebia centrifuga Karst. / Sweden, Canada / Hallenberg (1981 b), *Phlebia radiata* Fr. / France, Canada / Boidin and des Pomeys (1961),

Phlebia rufa (Fr.) M.P. Christ. / France, Canada / Ginns (1976),

Schizopora radula (Pers.:Fr.)Hallenb. / Scandinavia, Austria, Canada / Hallenberg (1983 b),

Scytinostroma galactinum (Fr.)Donk / France, Kamchatka, Canada, Guyana, Ivory Coast / Boidin (1977),

Scytinostroma hemidichophyticum Pouz./ France, USA / Lanquetin (1973 b),

Serpula himantioides (Fr.)Karst. / Denmark, USA, India / Harmsen (1960),

Serpula lacrymans (Fr.)Karst. / Denmark, USA / Harmsen (1960),

Sistotrema brinkmannii (Bres.)John Erikss. / Europe, Canada, USA / sensu stricto: Hallenberg (1984); sensu Rogers (1944): Lemke (1969), Ulrich (1973),

Sistotrema oblongisporum M.P. Christ. & Hauersl. / Sweden, Canada, Australia / Hallenberg (1984),

Intercompatibility in species belonging to a mediterranian, subtropical or tropical fungus flora:

Duportella tristicula Pat./ Pakistan, Gabon, Central African republic / Boidin (1977),

Gloeodontia discolor (Berk.& Curt.)Boid. / Ivory Coast, Central African Republic, USA (Louisiana) / Maas Geesteranus and Lanquetin (1975),

Peniophora malenconii Boid.& Lanq. / Partial compatibility between *P. malenconii* (Mediterranean) and *P. californica* nom. prov. (USA) / Boidin and Lanquetin (1977),

Scytinostroma duriusculum (Berk.& Br.)Donk / Sri Lanka, USA (Texas), Martinique, Argentina, Ivory Coast, Central African republic / Boidin (1977), Lanquetin (1973 b),

Stecchericium seriatum (Lloyd)Maas G. / Ivory Coast, Guadeloupe/ Maas Geesteranus and Lanquetin (1975).

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A TAXONOMIC ANALYSIS OF THE SISTOTREMA BRINKMANNII COMPLEX (CORTICIACEAE, BASIDIOMYCETES)

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ABSTRACT. On the basis of incompatibility and basidiocarp morphology Sistotrema brinkmannii (Bres.) John Erikss. sensu Rogers has been divided into several entities. Six species are described as new but it is quite obvious that still more taxa remain to be found within this complex.

INTRODUCTION.

The genus Sistotrema (Corticiaceae) is characterized by urniform basidia with mostly 6-8 sterigmata, smooth spores, oil-rich hyphae, mostly with clamp connections. The lack of easily observed characters distinguishing the species, the abundance of crystalline material - esp. in old, badly preserved collections, the sometimes great morphological variation within the species have caused difficult problems for the taxonomists. An especially big problem is met with in the Sistotrema brinkmannii complex.

Biggs (1937) published the first descriptions of some different taxa within the S. brinkmannii-group based on compatibility tests. She was quite aware that these taxa represented independent species but didn't describe them as new because of practical difficulties in their identification. She used the name Corticium coronilla Höhn. & Litsch. for the complex and divided it into four groups: I, bipolar; II, homothallic; III, tetrapolar; and IV heterothallic but type of polarity unknown. Group III was divided into three subgroups.

Later, Rogers (1944) described Trechispora brinkmannii (Bres.) Rog. & Jacks. as "a collection of fungi exhibiting bewildering variability". He studied the type collections of Corticium octosporum Schroet. ex Höhn. & Litsch., C. coronilla, and C. brinkmannii Bres. He discussed the results of Biggs, but couldn't find any distinct morphological criteria to separate the different species involved. C. octosporum is now identified as an older name for S. commune John Erikss. and the combination Sistotrema octosporum (Schroet. ex Höhn. & Litsch.)Hallenb. has recently been made (Eriksson et al, 1984). I consider Sistotrema

coronilla (Höhn. & Litsch.) Donk ex Rogers to be a distinct species. Lemke (1969) and Ullrich (1973) presented extensive reports on the different incompatibility and polarity patterns within the S. brinkmannii complex, but they didn't relate their results to basidiocarp morphology of the different incompatibility groups involved. Ullrich (1973) didn't even relate his cultures to herbarium specimens. Therefore, his study is impossible to evaluate taxonomically.
During a three months stay in Canada, 1982, I collected several unnamed Sistotrema-species, most of which could be referred to the different groups mentioned by Biggs (1937) and Lemke (1969). Almost all specimens cited by Biggs and Lemke have been restudied and some of Lemke's cultures are used in this study. Unfortunately, Biggs's cultures were not preserved.

In this paper, six species are described as new, viz. S. adnatum, S. athelioides, S. biggsiae, S. binucleosporum, S. farinaceum, and S. porulosum.
Sistotrema brinkmannii, S. oblongisporum M.P. Christ. & Hauersl., and S. coronilla are also treated. There are enough characters to keep the different species distinct on morphological criteria and these characters are supported by compatibility tests. Use of incompatibility tests has made it possible to evaluate the intraspecific variation in those species where several different cultures were available.
Frances F. Lombard and Harold H. Burdsall Jr., Madison, Wisconsin, USA, have cultured a number of specimens of the S. brinkmannii complex for many years. They have kindly placed their material at disposal for the present study. Lombard has worked out the incompatibility systems for S. biggsiae and S. coronilla and in a separate publication will treat the culture characters of the species described here.

There are still taxonomic problems in S. brinkmannii sensu Rogers.
I. Judging from herbarium material (not cultured) there are some specimens similar to S. octosporum and S. coronilla (see below) but which probably represent distinct species.
Two close relatives of S. octosporum, viz. S. estonicum Parm. and S. camshadalicum Parm. are not dealt with in this study as cultures are lacking.
II. Within S. brinkmannii s. str., S. biggsiae, and S. coronilla, there are several cases of partial compatibility, despite that the specimens involved are morphologically indistinguishable from each other. These specimens have been collected in localities far enough from each other to exclude the possibility of homogenic incompatibility (Esser, 1974) but still in the same continent (N. America).
Partial compatibility can be explained by e.g. senescens of cultures, or speciation in progress. However, it is known since the studies by Biggs and Lemke, that polarity tests in S. brinkmannii s.l. not always turn out into a per-

fect, bipolar pattern. Genetical factors responsible for this imperfect behaviour may also account for incompatible matings in cases where partial compatibility has been found (see below, under S. brinkmannii). Matings where partial compatibility was found have been repeated. Further, partially compatible specimens are in this study regarded as conspecific when there are no obvious morphological differences between them.

METHODS.
The compatibility tests have been made on common malt agar plates. Matings between two single-spore- (SS-)cultures as well as di-mon matings (dicaryotic x monocaryotic culture) have been used. To determine the breeding ability (i.e. the ability to form clamps in matings) of the individual SS-cultures, matings between SS-cultures of each specimen were first made. In intercompatibility tests compatible mating types from each specimen have been used. Neohaploidizations have been made by culturing clamped mycelia on different concentrations of ox-gall in agar. The plates with a concentration where clamps disappear have then been homogenized in an "Ultra Turrax" homogenizator. After dispersal, haploid cultures have been obtained. Nuclear staining has been made with Giemsa according to Boidin (1958).

DESCRIPTION OF THE SISTOTREMA BRINKMANNII-GROUP.

Fruitbodies effuse, smooth or grandinioid; hyphae with clamps, walls hyaline; gloeocystidia absent; basidia urniform, normally with 6-8 sterigmata; spores less than 9 µm long, ellipsoid, subcylindrical, suballantoid, or subglobose, uninucleate (except for S. binucleosporum).

KEY TO THE SPECIES:

1. Spores subglobose
   1.1. Fruitbody closely adnate, spores 4-5,5 x 3-3,5 µm,
   S. diademiferum (Bourd.& Galz.)Donk
   (= Biggs group IV. Description, see Eriksson et al, 1984)
   1.2. Fruitbody of a loose texture, farinaceous, spores 2,5-3,5 x 2,3-2,5 µm,
   S. farinaceum
2. Spores ellipsoid, cylindrical or suballantoid
   2.1. Spores suballantoid
      2.1.1. Fruitbody pellicular, smooth
         2.1.1.1. Spores 7-9 x 2-2,5 µm,
         S. suballantosporum Hallenb. (Description, see Eriksson et al, 1984)
      2.1.2. Fruitbody adnate, smooth or grandinioid
         2.1.2.1. Fruitbody adnate, grandinioid, spores 4-4,5 x 2-2,3 µm
         S. brinkmannii
         2.1.2.2. Fruitbody tightly adnate, smooth, spores 4-6 x 1,5-1,8 µm,
         S. oblongisporum

2.2. Spores ellipsoid to cylindrical (adaxial side straight or almost so)

2.2.1. Fruitbodies with margin cordons

2.2.1.1. Hymenium continous, partly grandinioid, yellowish
S. coronilla

2.2.1.2. Hymenium porulose - fibrillose, smooth, white,
S. octosporum

2.2.2. Fruitbodies without margin cordons (but sometimes a fimbriate margin present)

2.2.2.1. Hymenium continous

2.2.2.1.1.Spores 6-8 µm long,

2.2.2.1.1.1. Fruitbody pellicular, margin fimbriate,
S. athelioides

2.2.2.1.1.2. Fruitbody adnate, margin thinning out,
S. adnatum

2.2.2.1.2. Spores up to 6,5 µm long, fruitbody subpellicular, membranaceous,
S. biggsiae

2.2.2.2. Hymenium porulose or nearly invisible when dried,

2.2.2.2.1. Fruitbodies brittle when dried, loosely attached, whitish,
S. octosporum

2.2.2.2.2. Fruitbodies not brittle, tightly adnate, greyish white or nearly invisible when dried

2.2.2.2.2.1. Fruitbodies hyaline, nearly invisible when dried,
S. binucleosporum

2.2.2.2.2.2. Fruitbodies greyish - whitish, porulose,

2.2.2.2.2.2.1. Spores cylindrical - suballantoid, 4-6 x 1,5-1,8 µm,
S. oblongisporum

2.2.2.2.2.2.2. Spores ellipsoid, 3,5-4,5 µm long,
S. porulosum.

DESCRIPTION OF SPECIES AND RESULTS OF COMPATIBILITY TESTS.

The data on specimens and cultures studied are given with slant lines in between:
Culture or specimen number/ substrate/ locality/ date and collector/ number of single-spore-(SS)cultures and polyspore-(PS)cultures or SS-numbers of compatible mating types found. Compatible mating types are separated by a slant line, "/".
Cultures with a "GB-number" have been collected and isolated by me or other members of the mycological research group in Göteborg, those from USA have been provided by Mrs. F. F. Lombard, Madison, USA.

SISTOTREMA BRINKMANNII (Bres.) John Erikss.

Fruitbody effuse, soft when live, very brittle when dry; hymenium grandinioid (smooth and porulose when very young), whitish; spores 4-4,5 x 2-2,3 µm, suballantoid. Figs. 1D, 2.
For a detailed description, see Eriksson et al (1984).

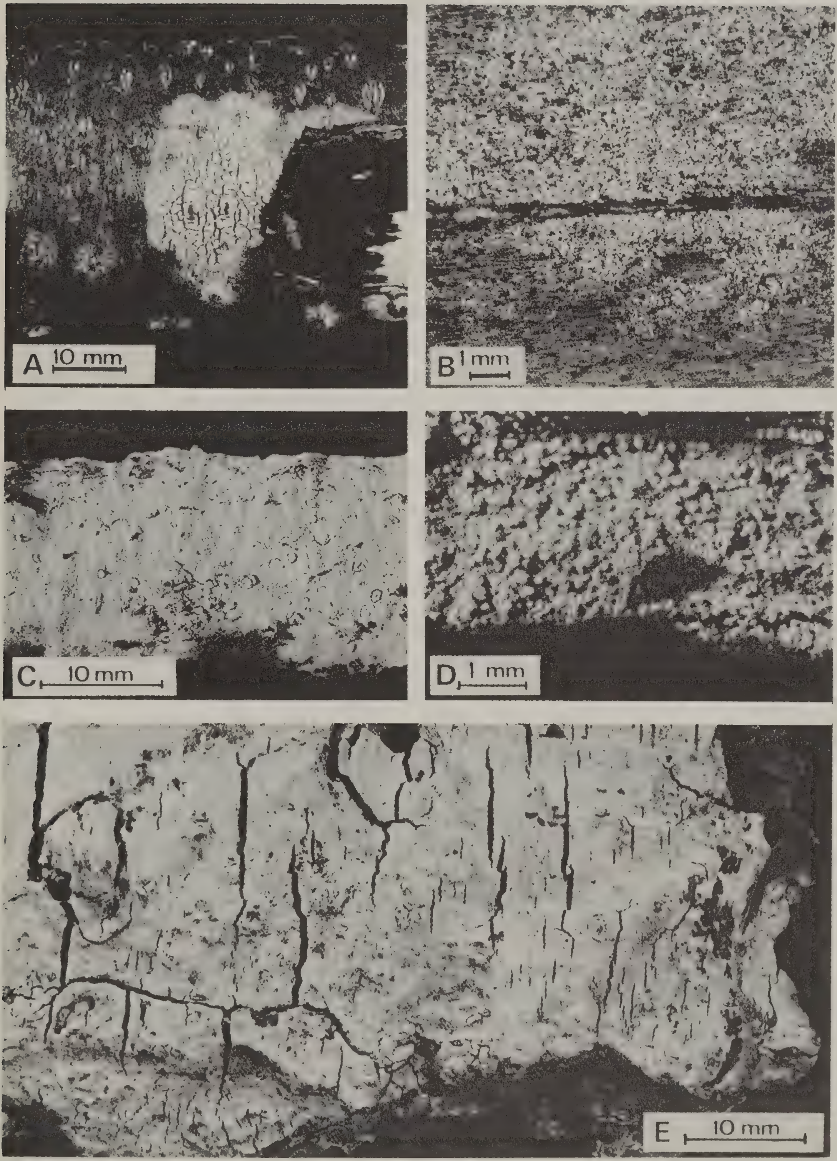
A 10 mm
B 1 mm
C 10 mm
D 1 mm
E 10 mm

Fig. 1. Dried fruitbodies in A) Sistotrema porulosum, GB 566, B) do., GB 720, C) S. oblongisporum, coll. J. Jeppson 910, D) S. brinkmannii, type, E) S. adnatum, GB 700. - Photo T. Hallingbäck.

Cultured material, bipolar form:

GB 40/ On a fallen branch/ Sweden, Skåne, Hallands Väderö/ 3 SS.

GB 75/ On a fallen branch of Fraxinus/ Denmark, Jylland, Mols Bjerge/ 1,5,7/ 4,9.

GB 209/ On coniferous wood/ Sweden, Östergötland, Omberg/ 7 SS.

GB 234/ On a fallen branch of Sarothamnus/ Denmark, Jylland, Mols Bjerge/ 5 SS.

GB 235/ On a fallen branch of Sarothamnus/ Denmark, Jylland, Mols Bjerge/ 6 SS.

GB 241/ On the pore layer of Phellinus nigricans/ Sweden, Torne Lappmark, Abisko Nat. Park/ 5 SS.

GB 242/ On a fallen trunk of Betula/ Sweden, Torne Lappmark, Abisko Nat. Park/ 3 SS.

GB 315/ On a fallen twig of a deciduous tree/ Sweden, Närke, Herrfallsäng/ 5 SS.

GB 382/ On a fallen log of Fagus/ Austria, Steiermark, Mt Schöckel/ 6 isolated SS, all clamped. In intercompatibility tests, di-mon matings or neohaplonts were used.

GB 559/ On a fallen log of Acer/ Canada, Quebec, Gatineau Nat. Park/ 3 SS.

GB 570/ On a fallen branch of yellow birch/ Canada, Quebec, Gatineau Nat. Park/ 1,4/ 3.

GB 600/ On a fallen log of a deciduous tree/ Canada, Quebec, Cantley/ 1/ 2,3.

DAOM 129780/ On Pinus stump/ France, Corsica, between Zonza and Ghisoni/ 1 PS.

HHB-7604-sp/ On Acer saccharum/ USA, Michigan, Big Bay/ 1,5/ 4,7.

HHB-8638-sp/ On Populus/ USA, Arizona, Pima County/ 12,15/6,10.

SH 4CB/ Old stump of Pseudotsuga menziesii/ USA, Oregon, Willamette Nat. Forest/ 7, 10/ 4, 5.

Homothallic form (neohaploidisation does not result in stable, haploid cultures, di-mon matings with bipolar form negative):

GB 244/ On a fallen branch of Salix/ Sweden, Torne Lappmark, Abisko Nat. Park/ 6 isolated SS, all clamped.

GB 544/ On a fallen branch of a deciduous tree/ Canada, Quebec, Cantley/ 5 isolated SS, all clamped.

CYTOLOGY. Spores uninucleate, SS-cultures with uninucleate cells (bipolar form), PS-cultures dicaryotic and regularly clamped.
In the homothallic form, the spores are also uninucleate, SS-cultures uninucleate and simple-septated during the first days, then turning directly over into the dicaryotic state with clamps (primary homothallism).

POLARITY. Bipolar and homothallic forms are known (see also Biggs 1937, Boidin 1958, Lemke 1969).

The above mentioned specimens of the bipolar form were found to be compatible with each other in most matings, however partial compatibility and incompatibility were noted in the following cases ("+" means that only few clamps are found, limited to the confrontation line):

	GB 75-1	GB 75-9	GB 234-1	GB 234-2	GB 242-1	GB 242-2	GB 600-1	GB 600-2	HHB-7604-1	HHB-7604-4	HHB-8638-6	HHB-8638-12	SH 4CB-4	SH 4CB-7
HHB-7604-1	-	-	+	+	-	+	+	+	-	+	-	-	-	±
HHB-7604-4	±	±	-	-	-	-	+	+	+	-	-	-	±	±
HHB-8638-6	-	-	-	-	-	-	+	+	-	-	-	+	±	±
HHB-8638-12	-	-	-	-	-	-	+	+	-	-	+	-	-	-
SH 4CB-4	+	+	+	+	-	+	+	+	-	±	±	-	-	+
SH 4CB-7	+	+	±	+	+	+	+	+	±	±	±	-	+	-

Also some of the matings in the polarity tests failed to result in clamp-formation (or with only a few clamps on the confrontation line) when expected according to the bipolar pattern.

Both Biggs (1937) and Lemke (1969) reported about the same behaviour. However, Lemke found that when nutritionally forced SS-cultures were paired in all combinations a perfect bipolar pattern was obtained. Thus, it is concluded that S. brinkmannii is a true bipolar species but with an imperfect ability to produce clamps (and dicaryons) in certain combinations under normal conditions. It is probably a genetical factor additional to the incompatibility system which affects the ability to produce clamps in these cases. The same genetical factor may be responsible for the cases with partial or imperfect compatibility between different specimens. However, there are also other possible explanations, e.g. normal heterogenic incompatibility or even senescens of cultures.

Also Lemke (1969) found partial compatibility between different specimens within his bipolar group.

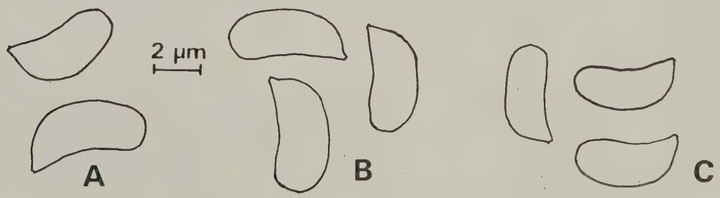

Fig. 2. Sistotrema brinkmannii, spores from spore-prints, A) GB 75, B) GB 244, C) GB 600.

Incompatibility was found between S. brinkmannii and S. oblongisporum (GB 303, GB 469, GB 511, GB 512, GB 721, DAOM 130616), S. porulosum (GB 566), S. athelioides (GB 701), S. biggsiae (GB 782), S. coronilla (GB 784).

REMARKS. S. brinkmannii is characterized by the grandinioid fruitbody and the suballantoid spores. Both heterothallic (bipolar) and homothallic forms are known. Even if matings in nature seem to be unlikely between these forms they are both given the same name as no morphologically distinguishing characters have been found.

Biggs group II (homothallic) belongs to this taxon and (at least) two of the bipolar specimens used by Lemke (1969) PAL 128 (= DAOM 129780) and PAL 129. Lemke also reported that he had succeeded (with the use of nutritional forcing) to get heterokaryons by pairing the homothallic form with the bipolar form. As his bipolar group consisted of (at least) two independent species (S. brinkmannii and S. oblongisporum, see below under the latter species) it is possible to explain why some of his crossings (bipolar x homothallic) failed to give clamp-connections. Neither did his crossings between nutritionally forced cultures of homothallic and tetrapolar form result in heterokaryosis, because the tetrapolar form belongs to still another species, viz. S. coronilla.

SISTOTREMA OBLONGISPORUM M.P. Christ. & Hauersl.

Fruitbody effuse, tightly adnate, thin; hymenium smooth, porulose - continuous, greyish white; spores straight to slightly bent. The specimens in the compatibility group (mentioned below) measure 4-5 x 1,5-1,8 (-2) µm. The type collection has slightly longer spores (5-6 µm) which are straight or only slightly bent. Among herbarium specimens the spore length varies and culture tests will be necessary to decide whether the long-spored and short-spored forms represent distinct species or not. Figs. 1C, 3.
For a detailed description of the species, see Eriksson et al (1984).

Cultured material:
GB 303/ On a fallen branch of Alnus/ Sweden, Lake Mälaren, Högholmsskär/ 2,5/4.
GB 469/ On twigs of a deciduous tree/ Sweden, Västergötland, Alingsås/ 1,5,6,8/2,3,4,7 .
GB 511/ On a fallen branch of a deciduous tree/ Sweden, Värmland, N. Ullerud par./ 1,3,4,6,7,8/ 2,5,9,10 .
GB 512/ On a fallen branch of a deciduous tree/ Sweden, Värmland, N. Ullerud par./ 1,3,4,6/ 2,5,7,8,9,10 .
GB 721/ On a hanging branch of a deciduous tree/ Canada, British Columbia, Vancouver/ 2/4 .
DAOM 130616/ On Pinus radiata stump/ Australia, Adelaide/ 1 PS.

CYTOLOGY. Spores are uninucleate, SS-cultures with uninucleate cells, PS-cultures dicaryotic and clamped.

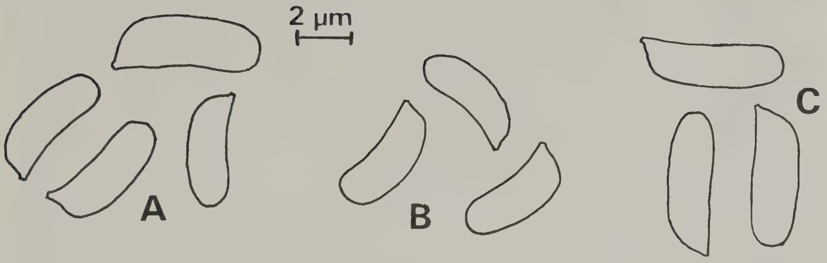

Fig. 3. Sistotrema oblongisporum, spores from spore-prints, A) GB 303, B) GB 721, C) spores from the fruitbody in the type.

POLARITY. S. oblongisporum is bipolar, without any obvious irregularities.

The above mentioned specimens were compatible with each other.
Heterogenic incompatibility was found between S. oblongisporum and S. brinkmannii (GB 75, GB 209, GB 241, GB 242, GB 570, GB 600, HHB-7604, HHB-8638, HHB-9213, SH-4CB, DAOM 129780), S. porulosum (GB 566).

REMARKS. S. oblongisporum is most closely related to S. brinkmannii but is distinguished by a smooth, adnate fruitbody of a more firm consistency, and by narrower, frequently straight spores. In the bipolar group reported by Lemke (1969), at least one specimen (PAL 121 = DAOM 130616) belongs to S. oblongisporum.

SISTOTREMA ADNATUM Hallenb. n. sp.

Fructificatio effusa, tenuis, adnata, hymenio levi, continuo, albescenti - cremaceo; systema hyphale monomiticum; hyphae 3,5-7,5 µm latae, in subiculo saepe ampullatae; basidia urniformia, 19-27 x 4,5-5,5 µm, 6 sterigmatibus; sporae ellipsoides, 6-8 x 2,8-3,3 µm, leves, tenuitunicatae.

Holotypus: GB 700/ On a fallen coniferous log/ Canada, British Columbia, Vancouver Island, Stratchona Prov. Park/ 1982-09-08, coll. N. Hallenberg/ 2SS + 1 PS.

Fruitbody effuse, thin, adnate; hymenium smooth, continuous, yellowish white to cream-coloured; margin narrow, thinning out.
Hyphal system monomitic; hyphae with clamps which frequently are ampullate (up to 15 µm wide); in subiculum the hyphae are straight and sparsely septated, 4-7,5 µm wide, slightly thick-walled, hyaline, interwoven but more or less parallel to the substrate; in subhymenium richly branched, thin-walled, 3,5-6 µm wide, content somewhat oily.

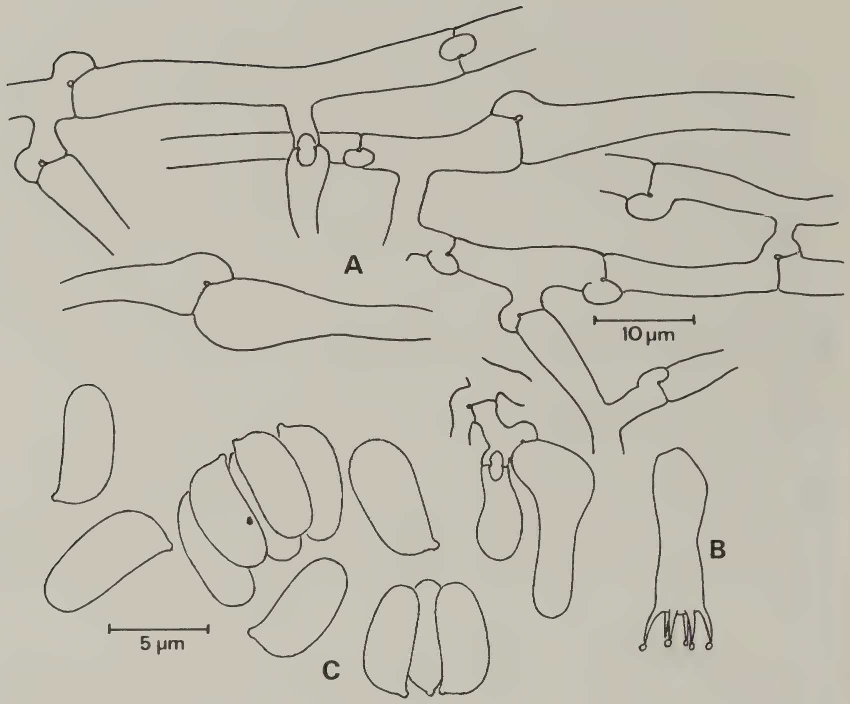

Fig. 4. Sistotrema adnatum. A) basal hyphae, B) young and mature basidia, C) spores - GB 700. Drawings by J. Eriksson.

Basidia urniform, 19-27 x 4,5-5,5 µm, with 6 sterigmata and basal clamp.
Spores ellipsoid, adaxial side straight, 6-8 x 2,8-3,3 µm, smooth, thin-walled.
Figs. 1E, 4.

CYTOLOGY. Spores uninucleate, SS-mycelium with uninucleate cells, PS-mycelium dicaryotic and regularly clamped.

POLARITY. S. adnatum is heterothallic. In di-mon matings the PS-culture mated SS-1 but not SS-2.

Heterogenic incompatibility between S. adnatum and S. biggsiae (GB 782), S. athelioides (GB 701).

REMARKS. This taxon belongs to the S. octosporum-group and is easily distinguished by the adnate fruitbody with a continous hymenium, the wide subicular hyphae with large ampullate clamps and the compact subhymenium.

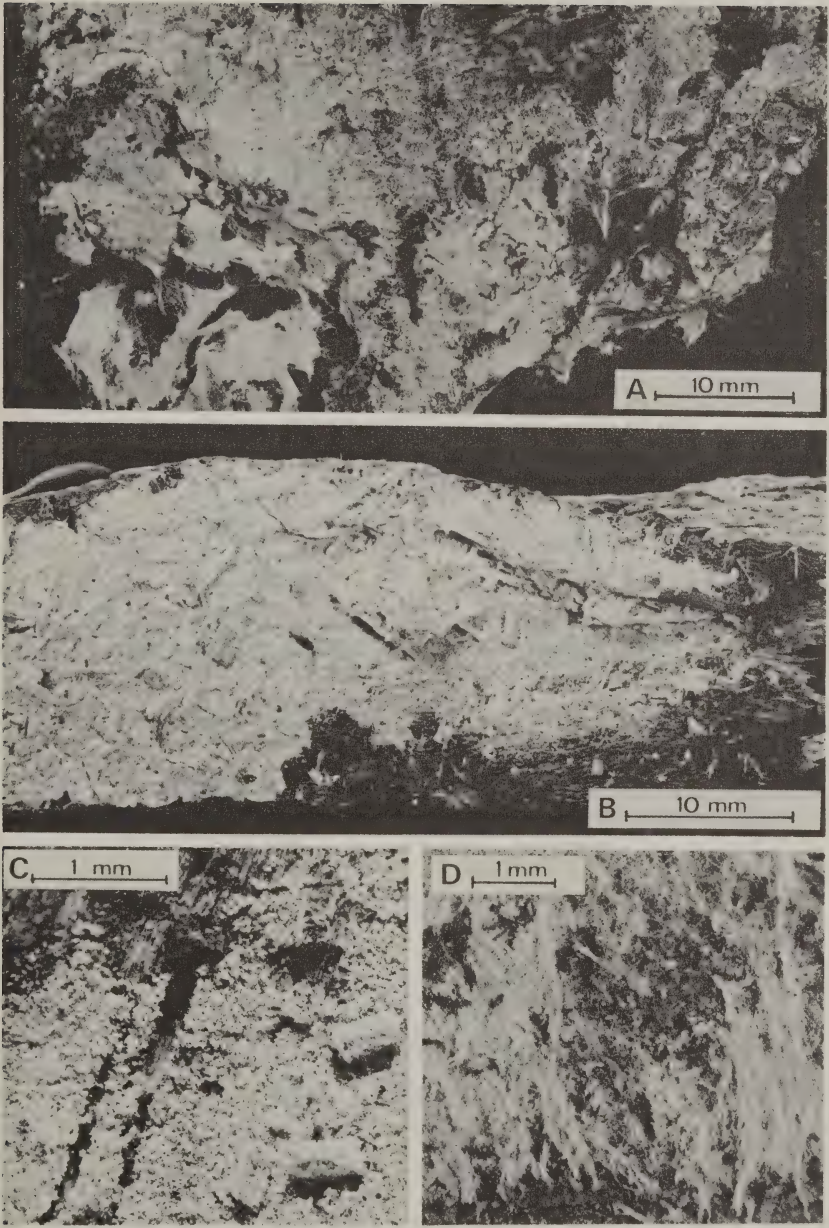
A
10 mm
B
10 mm
C
1 mm
D
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Fig. 5. Dried fruitbodies in A) Sistotrema athelioides, GB 701, B) S. biggsiae, GB 782, C) S. farinaceum, GB 659, D9 S. coronilla, GB 785. - Photo T. Hallingbäck.

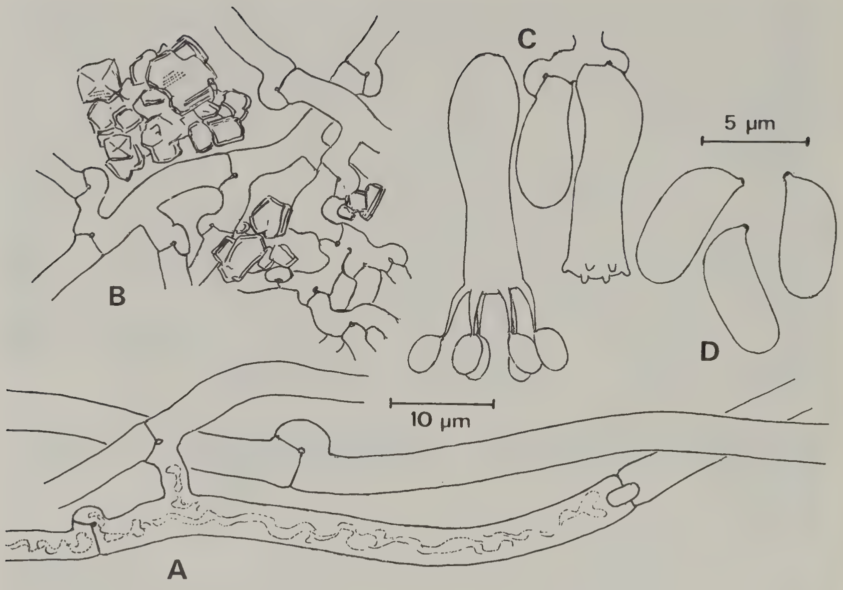

Fig. 6. Sistotrema athelioides, A) basal hyphae, B) subhymenial hyphae with crystalline deposits, C) basidia, D) spores - GB 701. - Drawings by J. Eriksson.

SISTOTREMA ATHELIOIDES Hallenb. n. sp.

Fructificatio effusa, pellicularis, hymenio levi, albescenti - cremaceo, subiculo arachnoide, margine fibrilloso; systema hyphale monomiticum; hyphae 3,3-6,5 µm latae, fibulatae, partim materiam flavidam, resinosam continentes, in subiculo fibulis ampullatis instructae; hyphae subiculares saepe in modum striarum conjunctae; basidia urniformia, interdum pedunculata, 16-32 x 5-6 µm, (4-)6-8 sterigmatibus; sporae subcylindraceae, 6-8 x 3-4 µm, leves, tenuitunicatae.

Holotypus: GB 701/ On a fallen coniferous log/ Canada, British Columbia, Vancouver Island, Stratchona Prov. Park/ 1982-09-08, coll. N. Hallenberg/ 1/2; 3,4/ .

Additional herbarium specimens:
NH 7133, NH 7156, same collecting data as above.

Fruitbody effuse, athelioid; hymenium smooth, detachable, yellowish white to cream-coloured; subiculum thick, cobwebby, whitish, composed of narrow strands; margin fibrillose. Hyphal system monomitic; hyphae with clamps which frequently are ampullate, 3,3-6,5 µm wide, usually with a yellowish, resinous content, stained brownish in sulfo-vanilline; subhymenial hyphae richly branched with crystalline deposits; subicular hyphae somewhat thick-walled, frequently united in strands.

Basidia urniform, mostly with a swollen base, some distictly stalked, 16-32 x 5-6 µm, with (4-)6-8 sterigmata and basal clamp.
Spores subcylindrical, 6-8 x 3-4 µm, smooth, thin-walled.
Figs. 5A, 6.

CYTOLOGY. Spores uninucleate, SS-mycelium with uninucleate cells, PS-mycelium dicaryotic and regularly clamped.

POLARITY. Heterothallic, but type of polarity unknown.

Incompatibility between *S. athelioides* and *S. adnatum* (GB 700), *S. biggsiae* (GB 782), *S. coronilla* (GB 785), *S. brinkmannii* (DAOM 129780).

REMARKS. *S. athelioides* belongs to the *S. octosporum*-group. It is easily distinguished from closely related taxa by the smooth, athelioid fruitbody with fibrillose margin (no cordons).

SISTOTREMA BIGGSIAE Hallenb. n. sp.

Fructificatio effusa, subpellicularis, membranacea, hymenio levi, continuo, cremaceo, margine determinato; systema hyphale monomiticum; hyphae 2,5-5,5 µm latae, fibulatae, saepe materiam flavidam, oleosam - resinosam continentes; basidia urniformia, 12-28 x 4-5,5 µm, 6-8 sterigmatibus; sporae subcylindraceae, 5-6,5 x 2,3-3 µm, leves, tenuitunicatae.

ETYMOLOGY. In memory of the exellent work by Rosemary Biggs (1937).

Holotypus: GB 782/ On a fallen log of Acer/ Canada, Quebec, Gatineau Nat. Park/ 1982-09-29, coll. N. Hallenberg/ 1,3/4; 2/ .
Additional cultured material:
GB 789/ On a fallen log of Abies/ Canada, Quebec, Gatineau Nat. Park/ 1 SS, 1 PS.
FP 101 111 / On Betula/ USA, Wisconsin, Minoqua, Kemp Biological Sta./ 5/12; 6/14.
Herbarium specimens:
RLG 10853/ On Salix gooddingii/ USA, Arizona, Santa Cruz County/ 1972-11-09, R.L. Gilbertson. This specimen was labelled *Sistotrema hirschii* (Donk) Donk, which is a quite different species (see Eriksson et al, 1984).
JE 8761/ On a fallen trunk of Populus/ Canada, Ontario, Petawawa Exp. Forest/ 1967-10-07, B. & J. Eriksson.
DAOM 10247/ On Populus/ Canada, Ontario, N. of Richmond Hill/ 1936-10-31, H.S. Jackson. Cited by Biggs (1937) as a representative for group III b.

Fruitbody effuse, subpellicular, membranaceous, of a loose consistency; hymenium smooth, continuous, cream-coloured; margin determinate.
Hyphal system monomitic; hyphae with clamps, slightly ampullate, frequently with a yellowish, oily or resinous content, stained brownish in sulfo-vanilline; in subhyme-

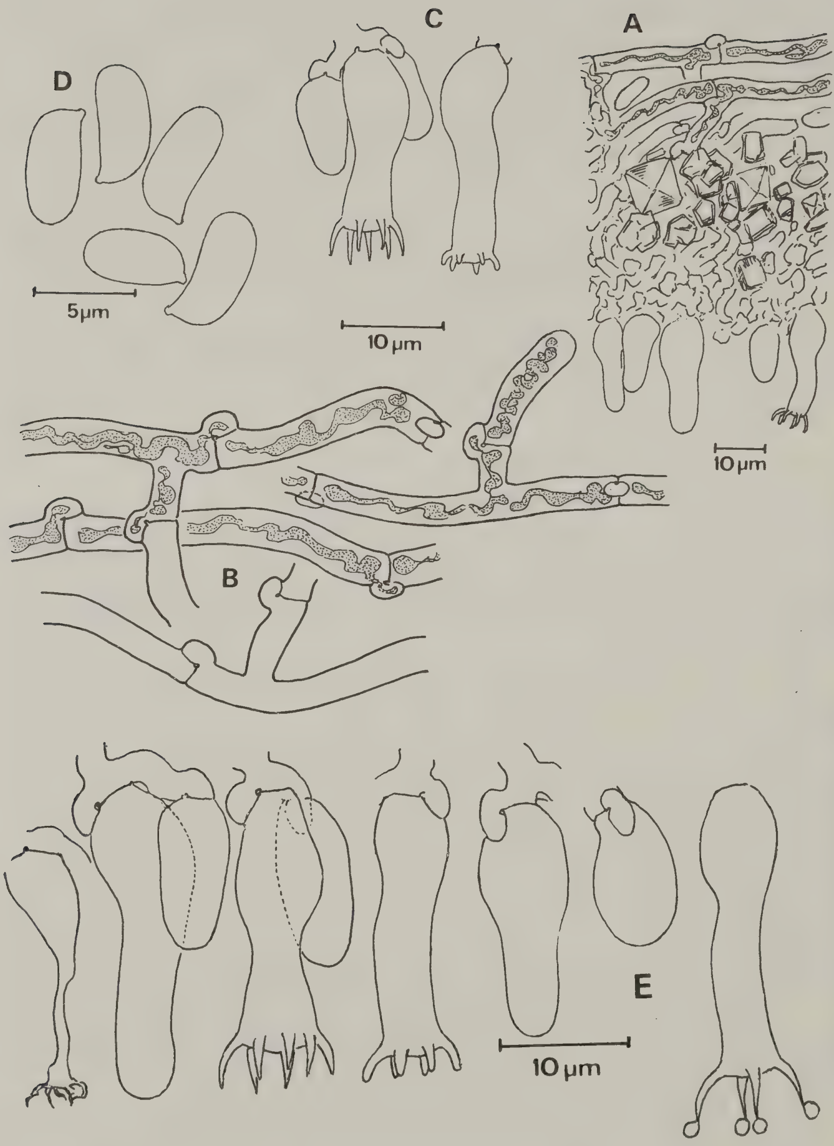
D
5µm
C
10 µm
A
10 µm
B
E
10 µm

Fig. 7. Sistotrema biggsiae, A) section through fruitbody, B) basal hyphae, C) basidia, D) spores - GB 782, E) hymenial details - RLG 10853. Drawings by J. Eriksson.

nium richly branched, 2,5-4,5 µm wide; in subiculum wider (up to 5,5 µm), with long cells, interwoven.
Basidia urniform, 12-28 x 4-5,5 µm, with 6-8 sterigmata and basal clamp.
Spores subcylindrical, 5-6,5 x 2,3-3 µm, smooth, thin-walled.
Figs. 5B, 7.

CYTOLOGY. Spores uninucleate, SS-mycelium with uninucleate cells, PS-mycelium dicaryotic and regularly clamped.

POLARITY. According to Lombard (in litt.) *S. biggsiae* is tetrapolar.

Compatibility has been found between GB 782 and GB 789, both of which were partially compatible with FP 101 111:

	GB 789-1	FP 101 111-5	FP 101 111-12	FP 101 111-6	FP 101 111-14
GB 782-1	+	+	+	+	+
GB 782-4	+	+	-	+	-
FP 101 111-5	+		+	-	-
FP 101 111-12	-	+		-	-
FP 101 111-6	+	-	-		+
FP 101 111-14	+	-	-	+	

Incompatibility between *S. biggsiae* and *S. brinkmannii* (DAOM 129780), *S. adnatum* (GB 700), *S. athelioides* (GB 701), *S. coronilla* (GB 785, HHB-7792, DAOM 52712).

REMARKS. Judging from herbarium material cited by Biggs (1937) as well as her culture description, *S. biggsiae* is a synonym of her group III b (tetrapolar). The species belongs to the *S. octosporum*-group but has also affinities with *S. resinicystidium* Hallenb. and *S. coroniferum* (Höhn. & Litsch.) Donk. Oil-rich hyphae and gloeocystidia in the latter two species have the same reaction with sulfo-vanilline as in *S. biggsiae*. Besides, the texture of their fruitbodies is similar. However, there are no gloeocystidia found in *S. biggsiae* and within the *S. octosporum*-group it is distinguished by the membranaceous fruitbody and lack of cordons and strands.

SISTOTREMA CORONILLA (Höhn. & Litsch.) Donk ex Rogers

Fruitbody effuse, pellicular, of a loose consistency; hymenium porulose to continous, smooth when young, when older grandinioid, yellowish to cream-coloured, whitish when young; margin with concolourous or whitish cordons. Brown

bulbils found in association with the fruitbodies in some specimens.
Hyphal system monomitic; hyphae with clamps, some cells filled with an oily or resinous content; subhymenial hyphae richly branched, 2,5-4 µm wide, thin-walled; subicular hyphae frequently running parallel in strands, sparsely septate, up to 6 µm wide, slightly thick-walled, with ampullate clamps.

Brown bulbils found in some specimens (fig. 8D) both in culture and in association with fruitbodies. The bulbils originate from small nodules of vesicular cells, formed on the mycelium. Similar nodules are found in S. brinkmannii and S. oblongisporum but in S. coronilla they develop into hollow bulbils, 50-90 µm in diam., their walls consisting of brown, irregularly angular cells, 15-30 µm across, joined into a pseudoparenchyma, one cell layer thick. The content is homogenously grainy and flows out in a coherent mass from the wall cells when squeezed under a cover slip. The brown cell walls are stained by cotton blue. The nature of these bulbils is unique within Corticiaceae and doubts concerning their origin could be raised. However, in preparations from fruitbodies with bulbils it is easy to observe the developmental stages as well as connections between clamped hyphae and mature bulbils. Besides, the same kind of bulbils are found in single-spore isolates as well as polyspore cultures. Weresub and LeClair (1971) describe this kind of bulbils and refer them to the imperfect genus Burgoa.

Basidia urniform, 11-23 x 4-5 µm, with (4-)6-8 sterigmata and basal clamp.
Spores ellipsoid to subcylindrical, 4,5-6 x 2-2,5 µm, smooth, thin-walled.
Figs. 5D, 8.

Cultured material:
GB 573/ On a fallen log of Acer/ Canada, Quebec, Gatineau Nat. Park/ 2 SS.
GB 776/ On a fallen branch of Fagus/ Canada, Quebec, Cantley/ 2,3,4,5/ 6.
GB 784/ On a fallen branch of a deciduous tree/ Canada, Quebec, Gatineau Nat. Park/ 1/ 2,3.
GB 785/ On a fallen log of a deciduous tree/ Canada, Quebec, Gatineau Nat. Park/ 1,2/ 3.
HHB-7792/ On Betula lutea/ USA, Michigan, Big Bay/ 17/19; 10/26 .
HHB-10379/ On Acer saccharum/ USA, Michigan, Big Bay/ 9,14/ 10,11 .
DAOM 52712/ On discarded fertilizer bags/ Canada, Ontario, Simcoe County/ 1 PS.

Additional herbarium specimens:
Austria, Wienerwald, Mödling/ 1904, Höhnel (Typus, in FH).
DAOM 10244/ On Betula lutea/ Canada, Ontario, Lake Temagami/ 1936-09-06, D.P. Rogers. Cited by Biggs (1937) as representative for group III a.
On Fagus silvatica/ Norway, Vestfold, Sem: Gullkronene/ 1979-09-14, E. Blomdal.

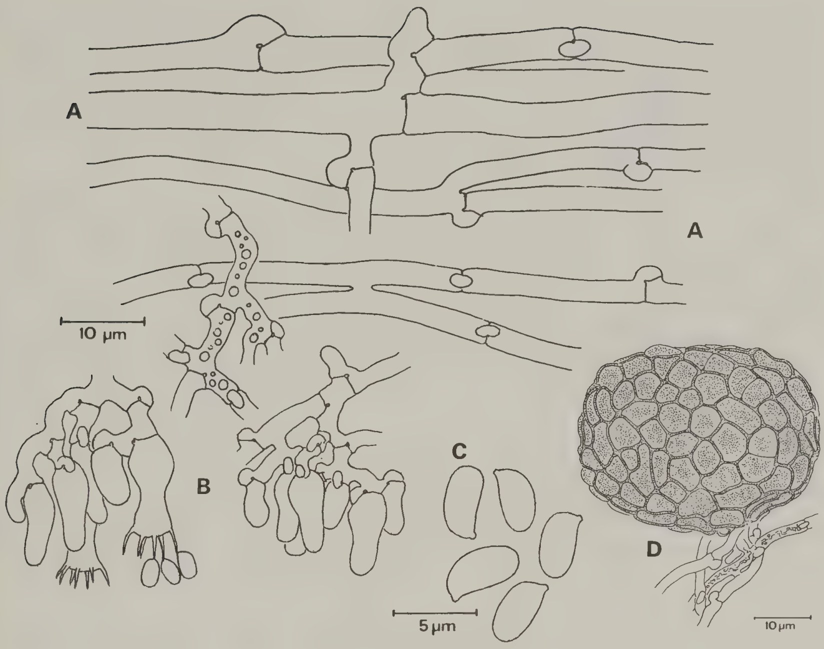

Fig. 8. Sistotrema coronilla, A) Basal hyphae, B) hymenial details, C) spores - GB 776, D) brown bulbil - DAOM 52712. Drawings by J. Eriksson.

CYTOLOGY. Spores uninucleate, SS-mycelium with uninucleate cells, PS-mycelium dicaryotic and regularly clamped.

POLARITY. According to Lombard (in litt.) S. coronilla is tetrapolar.

Compatibility was found among the above mentioned cultures except in the following cases (possibly due to homogenic incompatibility):
GB 776-2 x GB 785-1, 3 = +
GB 776-6 x GB 785-1 = -
x GB 785-3 = +, but unilateral dikaryotisation.
GB 784 was compatible with HHB 7792-26 (but only few clamps seen on the confrontation line), however, incompatible with HHB 7792-10,17,19, HHB 10379, and DAOM 52712.

Lemke (1969) found a tetrapolar group within the S. brinkmannii complex. It belongs with certainity to S. coronilla as one of the cultures used by him (DAOM 52712) also is part of the compatibility group reported here. Heterogenic incompatibility between S. coronilla and S. brinkmannii (DAOM 129780), S. athelioides (GB 701), S. biggsiae (GB 782, FP 101 111).

REMARKS. S. coronilla is a member of the S. octosporum group. It is an easily recognized but variable species. Young fruitbodies are whitish, smooth, porulose and fragile. In older specimens cordons are well developed, hymenium is continous, grandinioid, pale yellowish. Specimens with a smooth hymenium are separated from S. athelioides by smaller spores and basidia.
Biggs group III a belongs to S. coronilla.

The occurrence of brown bulbils in association with the fruitbodies varies. In DAOM 52712 they are abundant, in GB 785 scattered, immature bulbils have been found in the context, but in the other specimens mentioned here they seem to be lacking. As already mentioned by Biggs (1937), the occurrence of bulbils may depend on environmental factors (i.a. the collecting season) and the age of the fruitbody. Some N. American specimens (in FH; including Biggs group III c - Medford, Massachusetts, leg. Linder) have abundant brown bulbils and are very close to S. coronilla differing, however, by having somewhat larger spores. It is most probably a distinct species. Also some Norwegian collections (in O) are similar to S. coronilla, but possess somewhat larger spores. In these, however, no brown bulbils have been found.

SISTOTREMA FARINACEUM Hallenb. n.sp.

Fructificatio effusa, tenuis, valde fragilis, laxe adnata, hymenio levi, poruloso, farinaceo, albescenti, margine determinato; materia crystallina abundans adest; systema hyphale monomiticum; hyphae 2-3,3 µm latae, fibulatae; basidia urniformia - ovata, 8-9,5 x 3-4 µm, 6-8 sterigmatibus; sporae subglobosae, 2,5-3,5 x 2,3-2,5 µm, leves, tenuitunicatae.

Holotypus: GB 659/ On a fallen log of Populus/ Canada, British Columbia, Vancouver Island, Mesachie Lake/ 1982-08-31, N. Hallenberg/ 1/5; 3/4 .

Fruitbody effuse, thin, loosely adnate, smooth, farinaceous, whitish; margin indeterminate, whitish colour and the farinaceous appearance caused by abundant crystal material in the fruitbody. True hymenium lacking; basidia scattered in clusters on basal hyphae between abundant crystalline material. Hyphal system monomitic; hyphae with clamps, slightly ampullate, 2-3,3 µm wide, thin-walled.
Basidia urniform to ovate, 8-9,5 x 3-4 µm, with 6-8 sterigmata and basal clamp.
Spores subglobose, 2,5-3,5 x 2,3-2,5 µm, smooth, thin-walled.
Figs. 5C, 9.

CYTOLOGY. SS-mycelium with uninucleate cells, PS-mycelium dicaryotic and regularly clamped.

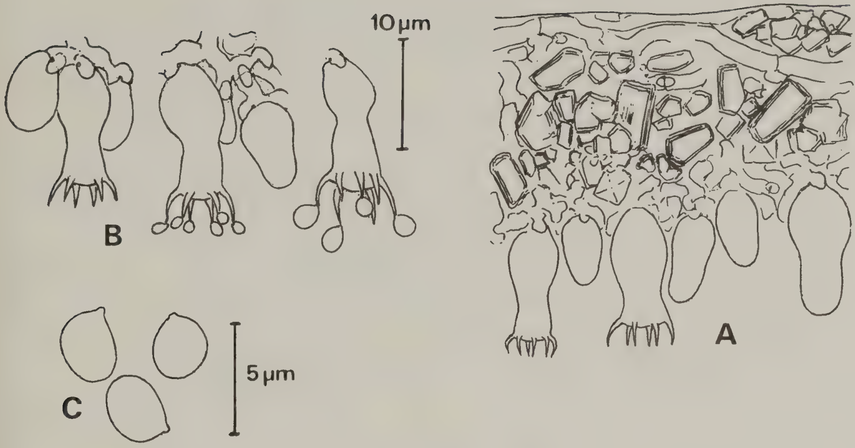

Fig. 9. Sistotrema farinaceum, A) section through fruitbody, B) hymenial details, C) spores - GB 659. Drawings by J. Eriksson.

POLARITY. Only four SS-cultures available but tetrapolarity is indicated.

Incompatibility between S. farinaceum and S. porulosum (GB 720), S. binucleosporum (GB 797).

REMARKS. Easily recognized taxon, distinguished by the farinaceous fruitbody with abundant crystals and the small basidia and spores.

SISTOTREMA PORULOSUM Hallenb. n. sp.

Fructificatio effusa, tenuis, dense adnata, hymenio levi, poruloso, pallido, subiculo valde tenui, margine indeterminato; systema hyphale monomiticum; hyphae 3-4 µm latae, fibulatae, partim materiam flavidam, oleosam continentes; basidia urniformia, 10-20 x 3,5-4,5 µm, 6-8 sterigmatibus; sporae ellipsoides, 3,5-4,5 x 2-2,8 µm, leves, tenuitunicatae.

Holotypus: GB 566/ On a fallen branch of Acer/ Canada, Quebec, Gatineau Nat. Park/ 1982-07-25, N. Hallenberg/ 3/4; 1/ .
Additional culture:
GB 720/ On a fallen branch/ Canada, British Columbia, Vancouver/ 1982-09-14, N. Hallenberg/ 4 isolated SScultures, all clamped. Stable neohaplonts were obtained and used in intercompatibility matings.

Additional herbarium material:
DAOM 10240/ On Populus/ Canada, Ontario, Lake Temagami/ 193607-23, R. Biggs. Cited by Biggs (1937) as group I.

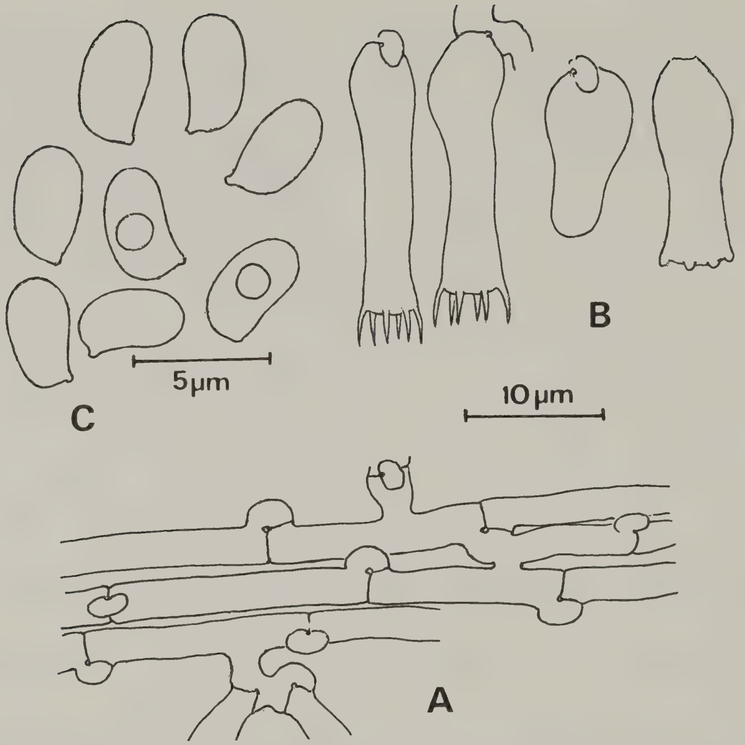

Fig. 10. *Sistotrema porulosum*, A) basal hyphae, B) basidia, C) spores - GB 566. Drawings by J. Eriksson.

Fruitbody effuse, thin, closely adnate; hymenium smooth, porulose, greyish; margin indeterminate.
Hyphal system monomitic; hyphae with clamps, sometimes ampullate, with an oily content, 2-4,5 µm wide; subiculum very thin and with rather sparsely septated hyphae, running parallell to the substrate, with thickened walls.
Basidia urniform, 10-20 x 3,5-4,5 µm, with (4-)6-8 sterigmata and basal clamp.
Spores ellipsoid, 3,5-4,5 x 2-2,5 µm, smooth, thin-walled.
Figs. 1A, B, 10.

CYTOLOGY. SS-mycelium with 4-5 nuclei/cell (terminal cells), older parts of SS-mycelium with 1-4 nuclei/cell; PS-mycelium dicaryotic, with clamps.

POLARITY. Heterothallic, but type of polarity unknown.

Compatibility between G 566 and GB 720.
Incompatibility between *S. porulosum* and *S. brinkmannii* (GB 75, GB 242, GB 570, HHB-7604, HHB-8638, HHB-9213, SH-4CB), *S. oblongisporum* (GB 469), *S. farinaceum* (GB 659), *S. binucleosporum* (GB 797).

REMARKS. S. porulosum is characterized by the thin, adnate, porulose, grey fruitbody, and by the pluri-nucleate SS-mycelia. The small, ellipsoid spores separates it from S. oblongisporum

SISTOTREMA BINUCLEOSPORUM Hallenb. n. sp.

Fructificatio effusa, dense adnata, valde tenuis, in sicco subinvisibile, hymenio levi, poruloso, pallido, margine indeterminato; systema hyphale monomiticum; hyphae 1,5-3 µm latae, fibulatae; hyphae subhymeniales brevicellulares, dense confertae; basidia urniformia - ovata, 7-12 x 3-4 µm, 6-8 sterigmatibus; sporae ellipsoides - subcylindraceae, 3,3-3,8 x 1,5-1,8 µm, leves, tenuitunicatae, binucleatae.

Holotypus: GB 797/ On a fallen, coniferous log/ Canada, British Columbia, Vancouver Island, Stratchona Prov. Park/ 1982-09-08, N. Hallenberg/ 4 SS.
Additional herbarium material:
NH 7131, NH 7139, same collecting data as for GB 797.

Fruitbody effuse, closely adnate, very thin, when dry almost invisible; hymenium porulose, smooth, greyish; margin indeterminate.
Hyphal system monomitic; hyphae with clamps, 1,5-3 µm wide, thin-walled, hyaline; subhymenial hyphae richly branched and densely united, short-celled, originating from more straight and sparsely branched, basal hyphae.
Basidia urniform to ovate, 7-12 x 3-4 µm, with 6-8 sterigmata and basal clamp.
Spores ellipsoid to subcylindrical, 3,3-3,8 x 1,5-1,8 µm, smooth, thin-walled.
Fig. 11.

CYTOLOGY. Spores binucleate, SS-mycelium with 6-12 nuclei/cell.

POLARITY. Unknown, but 4 isolated SS were all without clamps, while the hyphae of the fruitbodies are constantly clamped. However, the identity of the four available SS-cultures is uncertain as I didn't succeed to get a PS-culture. Additional cultures are necessary to ascertain their origin.
The SS-cultures are characterized by undifferentiated, branched, simple-septate hyphae, 1,5-3,5 µm wide. It is noteworthy that the time for spore growth was long, 13 days.
All confrontations between these SS-cultures and those of S. porulosum and S. farinaceum were negative.

REMARKS. Even if the cultured SS-mycelia are of some other origin I am convinced that these specimens represent a distinct taxon. Among the hitherto known species in Sistotrema it seems to be rather isolated due to the binucleate spores, the very thin and firm fruitbody and the small basidia and spores.

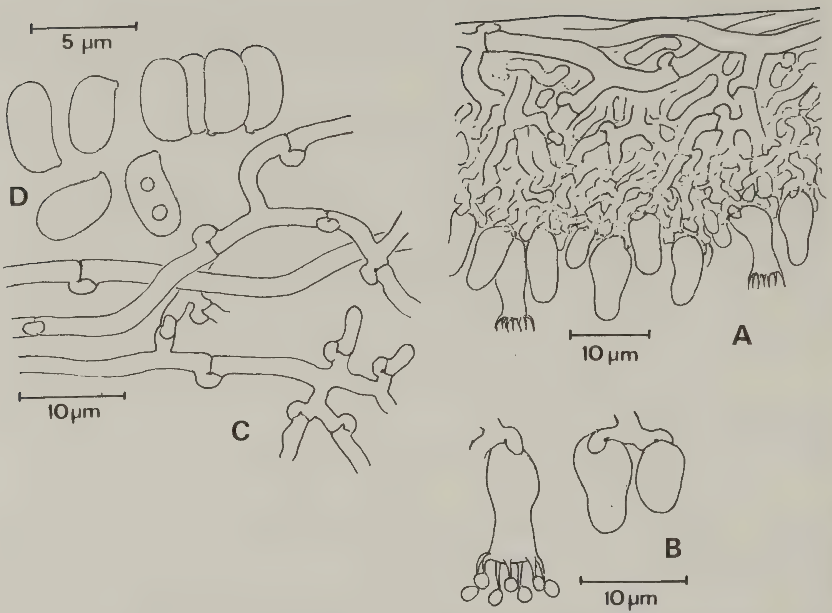

Fig. 11. Sistotrema binucleosporum, A) section through fruitbody - NH 7139, B) basidia, C) basal hyphae, D) spores - NH 7131. Drawings by J. Eriksson.

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NEW SOUTH AMERICAN SPECIES OF *PHELLINUS* (Hymenochaetaceae)

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SUMMARY

Six new species of *Phellinus* are herein described from Argentina, namely, *Ph. adhaerens, Ph. aureobrunneus, Ph. daedaliformis, Ph. elegans, Ph. garuhapensis* and *Ph. membranaceus,* and their relationships pointed out. A new name, *Ph. rickianus* Wright & Deschamps, is proposed for *Poria bambusarum* Rick, and a key to the species so far recorded in Argentina is added. A new combination is proposed, viz., *Ph. chaquensis* (Iaconis & Wright) Wright & Deschamps.

During the survey of the Hymenochaetaceae from Argentina and adjacent areas, which will be published "in extenso" at a later date elsewhere, six *Phellinus* species were found to be undescribed, for which reason we are proposing them as new. These new species do not seem to fit any of those recorded by Murrill (1908), Lloyd (1915, 1921, 1922), Teixeira (1962), Lowe 1957, 1960), Ryvarden & Johansen (1980) or David (1982).

The accompanying key includes not only the species studied in the present work, but also all those we have studied previously (Wright, Deschamps & Blumenfeld, unpublished).

METHODS

Microscopic examination of basidiocarps was made from freehand sections mounted in 5% KOH plus a drop of an aqueous solution of phloxine, in Melzer's reagent (Singer, 1949: 80) and in 0,5% cotton blue in 25% lactophenol. Drawings were made with a camera lucida. Herbarium abbreviations are according to Holmgren & Keuken (1974).

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[2] Member of the "carrera del personal de apoyo a la investigación científica y desarrollo" of the above Consejo.

KEY TO THE SPECIES OF *PHELLINUS* RECORDED FROM ARGENTINA AND NEIGHBORING AREAS

1. Fruitbodies resupinate..2
1'. Fruitbodies pileate (effused-reflexed, dimidiate or ungulate)..11

2. Hymenial setae absent..3
2'. Hymenial setae present...7

3. Basidiospores brown when mature................................4
3'. Basidiospores hyaline or light golden brown when mature.........5

4. Pores 6-7 per mm; tramal setae present; spores 7-9 x 5.5-7 µm. Southern Andes........................*Ph. andinum* Plank & Ryvarden
4'. Pores 3-4 per mm; tramal setae absent; spores ellipsoid, 4.1-4.6 x 2.6-3.6. Subtropical.................*Ph. adhaerens* nov. sp.

5. Spores typically dextrinoid, globose to ovoid, 3-5.7 µm; basidiocarp rather massive, usually thick (in many cases fried-egg shaped); pores 5-7 per mm; tubes usually slanted. Cosmopolitan in temperate regions...............................*Ph. punctatus* (Fr.)Pilát
5'. Spores non dextrinoid; basidiocarps very thin. Subtropical......6

6. Basidiospores subglobose, 3.1-5.2 µm; pores 6-8 per mm.Subtropical, on bamboo..........................*Ph. garuhapensis* nov. sp.
6'. Basidiospores ellipsoid, 3.1-4.2 x 2.6-3.1 µm; pores 4-6 per mm.Subtropical, on dicots.................*Ph. membranaceus* nov. sp.

7. Pores 1-4 per mm....................*Ph. contiguus* (Pers.:Fr.)Pat.
7'. Pores 4-10 per mm...8

8. Setae generally hooked; tropical to subtropical, on bamboo....... ....*Ph. rickianus* Wright & Deschamps nom. nov. (Basionym: *Poria bambusarum* Rick, Broteria 33: 146. 1937, non *Phellinus bambusarum* Pat., Essai Taxon. p. 97. 1900).
8'. On other substrates...9

9. Setae of two kinds: a) long and aciculate, projecting a long distance from the hymenium, 26-52 x 5.4-10.5 µm; b) scarce, subulate, embedded, 15-21 x 3-8.5 µm; tramal setae conspicuous. Cosmopolitan in temperate regions............................*Ph. ferruginosus* (Schrad.:Fr.) Pat.
9'. Setae different..10

10. Setae of only one type, subulate to ventricose, 35-50 x 3-6 µm; pores daedaloid, 4-5 per mm. Subtropical, on woodwork.................. ....*Ph. daedaliformis* nov. sp.
10'. Setae ventricose, many uncinate, 13.6-20.5 x 5.7-8.2 µm; pores circular, 4-6 per mm; spores 3.2-4.3 x 2.5-3.2 µm. Tropical to subtropical, on dicots......................*Ph. undulatus* (Murr.)Ryv.

11. Basidiospores hyaline.. 12
11' Basidiospores colored.. 17

12. Fruitbodies effused-reflexed, thin, dimidiate-applanate to conchoid; context yellowish brown (if brown and pileus conchoid, see 15) 13
12' Fruitbodies ungulate; if applanate, then with blunt margin; context deep brown... 16

13. Pores 4-6 per mm; context up to 1 cm thick................ 14
13' Pores 6-8(-10) per mm; context very thin, up to 0.2 cm thick 15

14. Pores circular, 5-6 per mm; setae ventricose to subulate, straight or hooked, 18-34 x 6-7.7 µm; spores ovoid to subglobose, 3.1-5.2 x 2.6-3.1 µm. Subtropical.............*Ph. wahlbergii* (Fr.)Reid
14' Pores 4-5 per mm, daedaloid; setae subulate to ventricose, 35-50 x 3-6 µm; spores short ellipsoid, 3'6-5.2 x 2.6-3.6 µm. Subtropical ....*Ph. daedaliformis* nov. sp.

15. Hymenial setae absent; spores globose, 4.6-5.7 µm. Subtropical ....*Ph. elegans* nov. sp.
15' Hymenial setae present, numerous, subulate, swollen at the base, 10.3-10.7 x 2.6-6.1 µm; spores oblong to narrowly ellipsoid, 2.8-3.7 x 2.5-3.6 µm. Cosmopolitan from temperate to tropical...... ....*Ph. gilvus* (Schw.)Pat. and its varieties

16. Fruitbodies relatively small; restricted to stone-fruit trees (*Prunus* spp.). Cosmopolitan............*Ph. pomaceus* (Pers.:S.F.Gray) Maire
16' Fruitbodies larger; on other substrates. Cosmopolitan.......... ....*Ph. igniarius* (L.:Fr.)Quél.

17. Fruitbodies golden brown; pileus surface velvety, azonate; context 0,5-2 cm thick, with a dark line at the base; spores globose, 3.6-5.2 µm. Subtropical to tropical.....*Ph. aureobrunneus* nov. sp.
17' Fruitbodies differently colored; pileus surface not velvety, or if so, then zonate... 18

18. Fruitbodies thin, applanate or conchoid; spores small, not exceeding 4 µm long. Subtropical..........*Ph. pectinatus* (Kl.)Quél.
18' Fruitbodies applanate to ungulate; spores longer than 4 µm..19

19. Setae generally abundant, ventricose........................20
19' Setae generally absent; if present, then subulate...........24

20. Fruitbodies dimidiate, applanate; pileus surface not rimose.21
20' Fruitbodies ungulate; pileus surface rimose.................22

21. Spores subglobose, 4-5 x 3,5-4 µm. Subtropical.............. ....*Ph. calcitratus* (B. & C.)Ryv.
21' Spores ellipsoid, 5.2-6.1 x 3.6-4 µm........................ ....*Ph. senex* (Nees & Mont.)Imazeki

22. Pores 5-10 per mm.. 23
22! Pores 3-6 per mm; spores ellipsoid, 3.2-6.1 x 3.1-4.6 µm. Temperate to subtropical.......................*Ph. everhartii* (Ell. & Gall.) Pilát

23. Fruitbodies distinctly ungulate; spores 4.5-6.5 x 3.9-5.2 µm; in xerophilous forests..................*Ph. chaquensis* (Iaconis & Wright)Wright & Deschamps comb. nov. (Basionym: *Fomes chaquensis* Iaconis & Wright, An. Soc. Cient. Arg. CLVI (1): 14. 1953)
23! Fruitbodies applanate to ungulate; spores 3.6-5.2 x 3.1-4.5 µm; in subtropical rain forest.............*Ph. linteus* (Berk. & Curt.) Teng

24. Fruitbodies thick, generally solid and heavy; skeletal hyphae thick-walled, rarely septate; temperate to subtropical, common in xerophytic forests on living Leguminosae..*Ph. rimosus* (Berk.)Pilát
24! Fruitbodies thin, light-weighted; skeletal hyphae conspicuously septate... 25

25. Pores 7-10 per mm; fruitbodies typically applanate, concrescent; context yellowish; spores 5-6 x 4.5-5.5 µm; in subtropical rain forest, on living and dead trees......*Ph. fastuosus* (Lév.) Ahmad
25! Pores 5-8 per mm; fruitbodies thick, not concrescent; context brown; spores 4.1-5.7 x 3.1-4.6 µm; temperate to subtropical...*Ph. swieteniae* (Murr.) Herrera & Bondartseva

DESCRIPTION OF SPECIES

PHELLINUS ADHAERENS sp. nov.

Basidiocarpo annuo, atrobrunneo ad margine flavescentibus margine irregulari, undulato, velutino, tenui, omnino adhaerenti. Contexto aureo-brunneo, usque ad 2 mm crasso. Hymenophoro tubulari, tubulis cylindricis, aliquantum laceratis, usque ad 3 mm long. Poris circularis, 3-4 per mm. Basidiis 5.2-7.1 x 4.1-5 µm, tetrasporis. Setis nullis. Basidiosporis brunneis, ellipsoideis, laevis, 4.1-4.6 x 2.6-3.6 µm, inamylrideis, acyanophilis. Systema hypharum cum hyphis generativis abundantissimis in contextis, 1.5-2.5 µm diam. et sceletis flavo brunneis, 1.5-3.6 µm diam.

HOLOTYPUS. Argentina, Entre Ríos, Palmar de Colón, La Calera, ad truncis cariosos Blepharocalyx Tweedii, in sylva marginali ad flumen Uruguay, leg. Del Busto & Deschamps, 11.IV.1971, in Herb. BAFC n¨24045 conservatus est.

Fruitbody annual, resupinate, totally attached to substrate, corky. Margin irregular, undulate, thin and velvety. Pore surface dark brown. Pores 3-4 per mm, round. Context thin, up to 0,2 cm thick, golden brown. Tubes slightly lacerate, up tp 0.3 cm long.

Hyphal system dimitic. Generative hyphae clampless, very abundant in the context, staining with phloxine, 1.5-2.5 µm wide. Skeletal hyphae yellowish brown, 1.5-3.6 µm wide. Hymenium 5.5-12 µm thick. Basidia claviform, 5.2-7.1 x 4.1-5 µm tetraspored. Basidiospores ellipsoid, brown, smooth, thin-walled, 4.1-4.6 x 2.6-3.6 µm, inamyloid, indextrinoid, acyanophilous. Setae none.

MATERIAL STUDIED: Argentina, Entre Ríos, Palmar de Colón, La Calera, leg. Del Busto & Deschamps, 11.IV.1971, on decayed trunk of *Blepharocalyx tweedii*, in marginal forest of Uruguay river (BAFC n°2045, HOLOTYPE).

REMARKS: *Ph. adhaerens* differs from *Poria melleopora* (Murr.)Sacc. & Trott. by its longer pores and annual fruitbody, and from *Ph. punctatus* in having a thin basidiocarp and smaller non dextrinoid spores. It is very close to *Ph. umbrinellus* (Pers.)Ryv. which has smaller pores (Ryvarden & Johanson, 1980). Our material was kindly examined by Dr. Lowe, who could not find a name for it.

PHELLINUS AUREOBRUNNEUS sp. nov.

Basidiocarpo annuo, aliquot pileis confluentibus, applanato, 3-7 x 1.5-3 x 1-4 cm, superficie concentrice sulcata, azonata, lignea, aureobrunnea, margine subacuto, sterili usque ad 4 mm contexto aureobrunneo vivido, lignoso-fibroso, crasso usque ad 20 mm, ad basim ligna nigra exornato. Hymenophoro tubulari aliquantum perfuscantibus, usque 5 mm long. superficie poris aureobrunnea, lucenti, velutinisque poris circularibus vel angularibus, 8-9 per mm. Basidiis globosis vel subglobosis. Basidiosporis castaneis, globosis, tenuitunicatis, 4.1-5.2 x 3.6 -5.2 µm. Systema hypharum cum hyphis generativis tenuitunicatis, ramificatis, regulariter septatis, 2-3 µm diam., et sceletis leviter crassetunicatis, rectis, 3.1-5.2 µm diam.

HOLOTYPUS. Argentina, Corrientes, Santo T omé, Garruchos, leg. Krapovicas et al., V.1974, ad truncis cariosos dicotyledones, in Herb. BAFC no. 24381 conservatus est.

Fruitbody annual, dimidiate, several pilei confluent, 3-7 x 1.5-3 x 1-4 cm. Pileus surface velvety, azonate, concentrically sulcate, woody, dark yellowish brown. Margin subacute, entire , sterile up to 0,4 cm from the edge. Pore surface golden brown, glistening, velvety. Pores 8-9 per mm, round to angular. Context vivid golden brown, fibrous, 0.5-2 cm thick, with a dark line at the base. Tubes up to 0.5 cm long, darker than the context.

Hyphal system dimitic. Generative hyphae clampless, branched, thin-walled, regularly septate, 2-3 µm wide. Skeletal hyphae unbranched, slightly thick-walled, 3.1-5.2 µm wide. Hymenium 5-10.3 µm thick. Basidia claviform to subglobose, 6-7.7 x 5.2-7.1 µm, tetraspored. Basidiospores globose, brown, thin-walled, 4.1-5.2 x 3.6-5.2 µm, inamyloid, acyanophilous. Setae none. Cystidia lacking.

MATERIAL STUDIED: Argentina, Corrientes, Santo Tomé, Garruchos, leg. Krapovicas et al., V.1974 (BAFC n°24381,HOLOTYPE). On decayed trunks of dicots.

REMARKS: the remarkable characters of this species are the color, principally the vivid golden brown context; the absence of setae; the distinct dark line at the base of the context and the small pores. It differs from *Ph. rheicolor* (Lloyd)Ryv. - whose type is sterile and purported to have been sent to Lloyd from Argentina, but doubtfully so - by the lack of setae. We thus prefer to maintain our species separate for the time being. Lowe (1957) states it resembles *Ph. rhabarbarinus* (Berk.) Cunningh., but our species differs from the latter by the habit, the lack of setae and the brown spores. Ryvarden & Johansen (1980) place *Ph. rheicolor* in synonymy with *Ph. rhabarbarinus* and in turn place this name as a synonym of *Ph. rhytiphloeus*.All the group requires further study.

PHELLINUS DAEDALIFORMIS nov. sp.

Basidiocarpo annuo, aeffuso vel effuso-reflexo, solitario, 10-15 x 5-10 x 5-10 x 1-5 cm, in sicco suberoso, superficie velutina, flavo-brunnea margine acuto, leviter recurvato. Contexto ligneo, brunneo, usque ad 3 mm crasso. Hymenophoro tubulari, aliquantum contexto pallidis, usque ad 4 mm long. poris daedaloides vel oblongis vel irregularibus, laceratis, 4-5 per mm. Basidiis claviformibus vel subglobosis, 7.7-10.3 x 4.1-5.2 µm. Setis abundantibus, subulatis vel ventricosis,crassetunicatis, 35-50 x 3-6 µm. Basidiosporis breviter ellipsoideis, hyalinis, tenuitunicatis, 3.6-5.2 x 2.6-3.6 µm, inamyloideis, acyanophilis. Systema hypharum cum generativis tenuitunicatis, ramificatis, 1.5-2 µm diam. et sceletic simplices, parietis plus minusve crassetunicatis, 2-4 µm diam.

Holotypus. Argentina, Misiones, San Ignacio Miní, Ruinas Jesuíticas, ad trabes cariosos Tabebuiam, in Herb. BAFC no. 24.378 conservatus est.

Fruitbody annual, resupinate to effused-reflexed, 1-1.5 x 0,5-1 x 0,2-0.5 cm., corky when dry. Margin acute, yellowish brown, velvety, somewhat incurvate. Pore surface velvety, light brown; pores 4-5 per mm, daedaloid to, less frequently angular or oblong. Context woody, brown,up to 0.3 cm thick. Tubes lighter than the context, lacerate, up to 0.4 cm long.

Hyphal system dimitic; generative hyphae simple septate, thin-walled, branched, 1.5-2 µm wide, skeletal hyphae thick-walled, unbranched, 2-4 µm diam. Hymenium 5-16 µm thick. Basidia subclaviform to claviform, 7.7-12.9 x 3.6-4.7 µm, tetraspored. Basidiospores shortellipsoid, hyaline, thin-walled, 3,6-5,2 x 2,6-3,6 µm, non dextrinoid, acyanophilous. Setae abundant, subulate to ventricose, thick-walled, 35-50 x 3-6 µm.

MATERIAL STUDIED: Argentina, Misiones, San Ignacio Miní, Jesuitic ruins, leg. Wright, Deschamps & Del Busto, 25.X.1973, on decayed banister of Tabebuia (BAFC no. 24.378,(HOLOTYPE).

REMARKS: The type was kidnly examined by Dr. Pegler and Dr. Reid, from the Royal Botanic Gardens, Kew, who could not find a name for it; this would confirm our notion that *Ph.daedaliformis* is a new species.

PHELLINUS ELEGANS nov. sp.

Basidiocarpo perenni, applanato, dimidiato, 50 x 30 x 10 mm, superficie pilei glabra, concentrice zonata, lignosa, atrobrunnea, margine tenui, sterili usque ad 3 mm. Contexto brunneo vivido, lignoso, tenuissimo usque ad 2 mm crasso. Hymenophori tubulari, tubulis non stratosis vel obscure stratosis ad marginem, brunneis, usque ad 2 mm long. per strato. Poris brunneo-cinereis, flavescentibus versus marginem, circularis vel angularis, 7-8 per mm. Basidiis subglobosis, tetrasporis, 7.1-10.3 x 4.5-6.1 µm. Basidiosporis subglobosis vel globosis, 4.6-5.7 µm, hyalinis, dextrinoideis. Systema hypharum cum hyphis generativis tenuitunicatis, non ramificatis, 1.-3.1 µm diam, et sceletis crassetunicatis, rectis, 2-4 µm diam.

Holotypus Argentina, Misiones, Parque Nacional Iguazú, Cataratas,

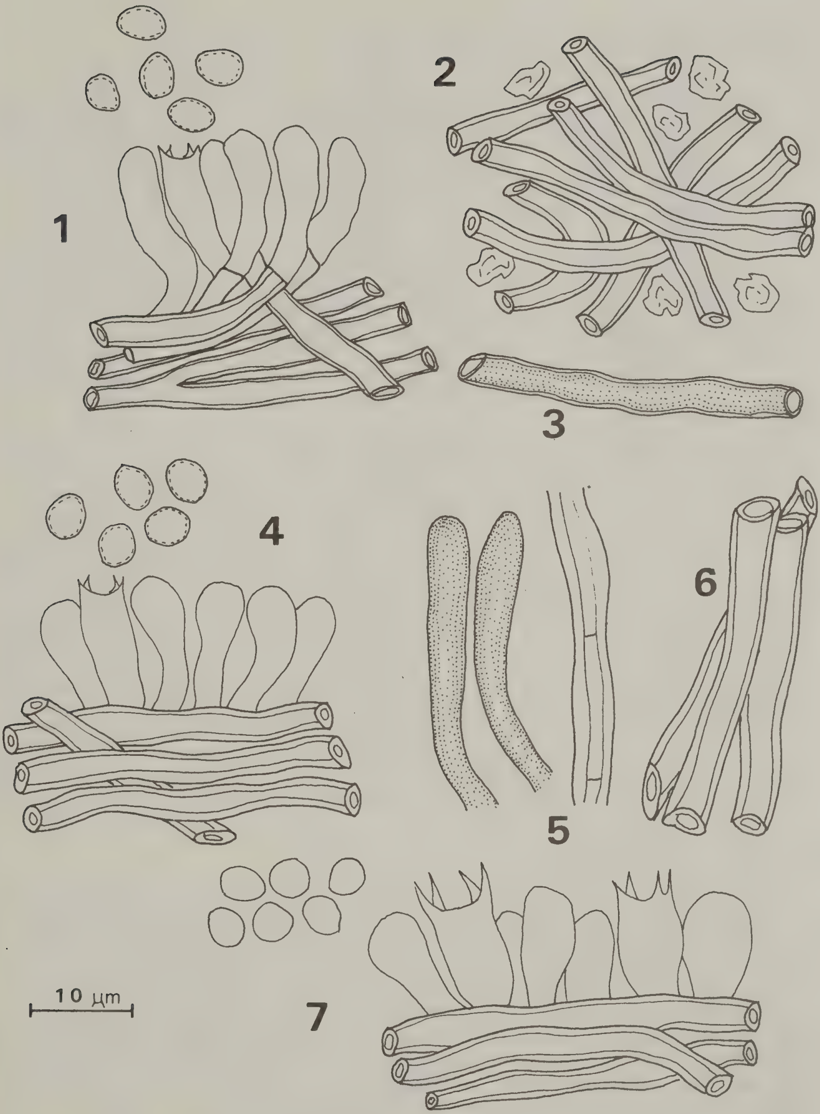


Fig. 1-3. *Ph. adhaerens* : 1. hymenium and basidiospores; 2. skeletal hyphae and crystals from the context; 3. simple septate generative hyphae.

Fig. 4-6. *Ph. aureobrunneus*: 4. hymenium and basidiospores; 5. simple septate generative hyphae and septate skeletal hyphae from the dissepiments; 6. skeletal hyphae from the context.

Fig. 7. *Ph. elegans*: hymenium and basidiospores.

ad ligno Ocoteam, leg. Wright, Deschampset Del Busto, 27.X.1973, in Herb. BAFC no. 24.382 conservatus est.

Fruitbody perennial, applanate, dimidiate, 5 x 3 x 1 cm; pileus surface glabrous, concentrically zonate and minutely undulate, dark brown to almost black. Margin acute, sterile up to 3 mm from the margin; pores 7-8 per mm, round to angular, pore surface cinereous brown, yellowish toward the margin. Context vivid golden brown, woody, up to 0.2 cm thick. Tubes stratified to poorly stratified, up to 0.2 cm long each layer, stuffed.

Hyphal system dimitic. Generative hyphae thin-walled, 1.5-3.1 µm diam. Hymenium 5-12 µm thick. Basidia subglobose, 7.1-10.3 x 4.6-6.1 µm tetra spored. Basidiospores subglobose to globose, hyaline, thin-walled, 4.6-5.7 µm, dextrinoid, acyanophilous. Setae absent. Cystidia lacking or rare, and then very small.

MATERIAL STUDIED: Argentina, Misiones, Parque Nacional Iguazú, Cataratas, leg. Wright, Deschamps & Del Busto, 27.X.1973, on Ocotea sp. (?) (BAFC 24.382, HOLOTYPE).

REMARKS: characteristic of this species are the dark concetrically zonate and sulcate pileus, the indistinctly stratified tubes, small pores, the globose, dextrinoid spores and the lack of setae. According to Dr. L. Ryvarden (personal communication), it comes very close to *Ph. robustus* "a very common species in Africa, America, Asia and Europe". We cannot but disagree with this statement in view of the marked differences found between our material and the typical *Ph. robustus* as represented in our herbarium. Our material differs from European specimens of the latter by the smaller pores, the colour of the pore surface, the narrow context, the hyaline spores, and the lack of conspicuous cystidia and "pseudosetae" (Ryvarden & Johansen, 1980). There is certainly nothing "robustus" about this species, and one would have to stretch the notion of this species far too much to accomodate the present one. It is our opinion that both the so-called "punctatus" and "robustus" group need critical studies including cultural and interfertility tests in order to sort out the species, particularly of the tropics.

PHELLINUS GARUHAPENSIS nov. sp.

Basidiocarpo annuo, resupinato, aureobrunneo` margine sterili, pallidior, undulato, tenuissimo, toto adhaerenti. Contexto brunneo, inconspicuo, usque ad 0.2 mm crasso. Hymenophoro tubulari, tubis curtis, usque ad 1 mm long. Poris circularibus, 6-8 per mm. Basidiis claviformibus tetrasporibusque, 7.8-8.3 x 6.2-5.7 µm, sterigmatibus usque ad 2.6 µm long. Cystidiolis tenuis hymenii abundantibus, claviformibus, angustatis versus apicibus. Setis nullis. Basidiosporis globosis, hyalinis, leviter crassetunicatis, guttulatis, apiculatis, 3.2-5.2 µm, indextrinoideis, acyanophilis, abundantibus. Systema hypharum cum paucis hyphis generativis tenuitunicatis, 1.3-2.6 µm diam., et hyphis sceletis brunneis, leviter crassetunicatis, 1.6-3.1 µm diam.

Holotypus. Argentina, Misiones, Garuhapé, leg. Gómez et Guerrero, VI.1965, ad bambuseam, in Herb. BAFC no. 29.452 conservatus est.

Fruitbody annual, resupinate, adnate. Margin light golden brown, undulate, very thin, totally attached to substrate. Pore surface golden brown; pores 6-8 per mm, circular. Context brown, inconspicuous, up to 0,2 mm thick. Tubes short, up to 1 mm long.

Hyphal system dimitic; generative hyphae thin-walled, simple septate

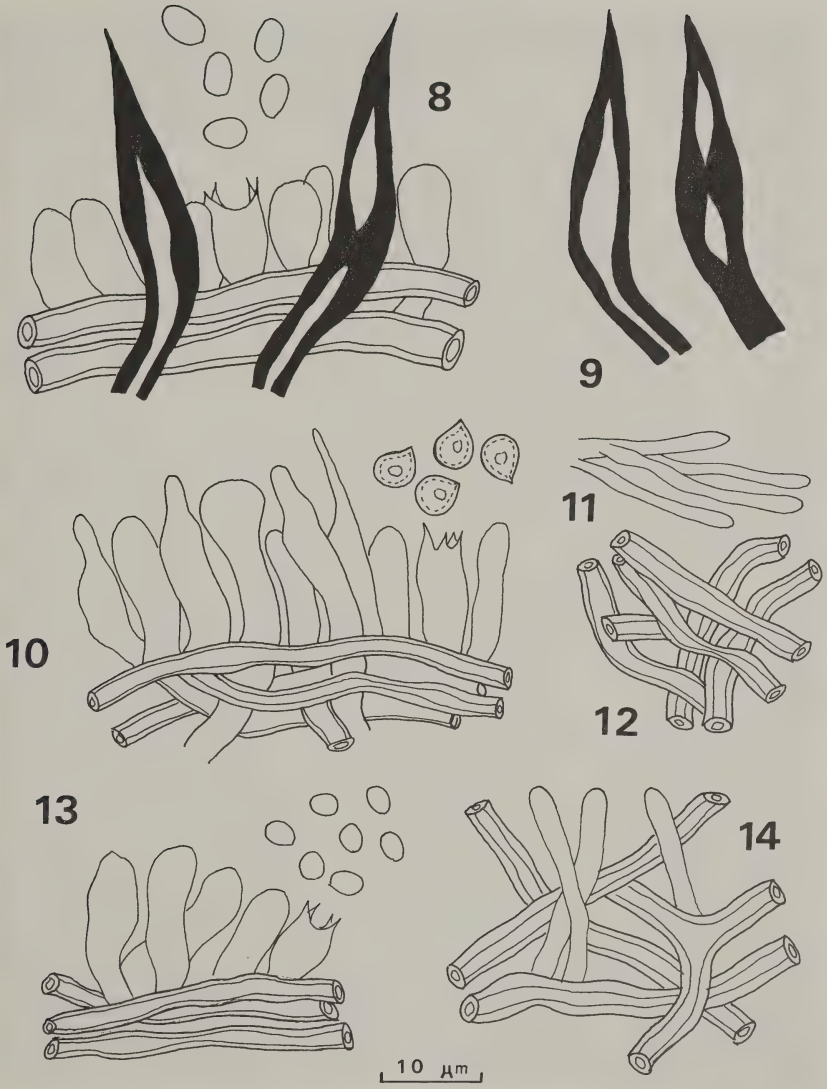


Fig. 8-9. *Ph. deadaliformis*: 8. hymenium and basidiospores; 9. setae.
Fig. 10-12. *Ph. garuhapensis*: 10. hymenium and basidiospores; 11. simple septate generative hyphae; 12. skeletal hyphae.
Fig. 13-14. *Ph. membranaceus*: 13. hymenium and basidiospores; 14. generative and skeletal hyphae.

1.3-2.6 µm wide. Skeletal hyphae brown, slightly thick-walled,1.6-3.1 µm diam. Hymenium 10-15 µm thick. Basidia claviform to cylindric, 6.5-10 x 4.5-5.7 µm, tetraspored, sterigmata up to 2.6 µm long. Basidiospores globose, hyaline, slightly thick-walled, guttulate, apiculate, 3.1-5.2 µm, inamyloid, indextrinoid, acyanophilous, very abundant. Cystidioles present in the hymenium, quite variable in number, claviform, tapering at the tip, 6.5-10 x 4.5-5.7 µm. Setae absent.

MATERIAL STUDIED: Argentina, Misiones, Garuhapé, leg. Gómez & Guerrero, VI.1965, on bamboo (BAFC 29.452, HOLOTYPE).

REMARKS: It differs from *Ph. membranaceus* by its spores, pore size, presence of cystidioles as well as by its substrate. According to Dr. Ryvarden (personal communication) it is close to *Ph. umbrinellus* from Southern Brazil, from which it differs by the substrate, which is on dicots in *Ph. umbrinellus* (Bres)Ryv. whose type we have studied, and by the entirely different colour of the pore surface.

PHELLINUS MEMBRANACEUS nov. sp.

Basidiocarpo annuo, resupinato, pallide isabellino vel pallide brunneo ad marginem sterili, undulato, solido adhaerente. Contexto brunneo usque ad 1 mm crasso cum strato nigro versus substrato. Hymenophoro tubulis cylindricis, curtis, usque ad 1.5 mm long. Poris circudaribus, 4-6 per mm. Basidiis claviformibus tetrasporibusque, 4.2-7.1 x 4.2-5.2 µm. Setis nullis. Basidiosporis ellipticis, hyalinis verl melleis, parietis tenui vel leviter incrassatis, paucis, 3.1-4.2 x 2.6-3.1 µm, inamyloideis, indextrinoideis, acyanophilis. Systema hypharum cum hyphis generativis tenuitunicatis, 2.6-4.7 µm,obsolescentibus in contexto, magis in dissepimentis, ey hyphis sceletis crassetunicatis, abundantissimis, 3.1-6 µm diam.

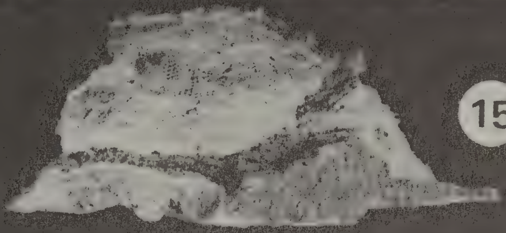
Holotypus. Argentina, Misiones, Parque Nacional Iguazú, ad viam Apepú, ad ligno latifoliato, leg. Rajchenberg, 8.III.1980, in Herb. BAFC no. 29.453 conservatus est.

Fruitbody annual, resupinate, firmly adhered to substrate; margin yellowish, sterile, undulate. Pore surface light isabelline brown to beige. Pores 4-6 per mm, round. Context brown, up to 1 mm thick,with a dark line near the substrate. Tubes short, up to.5 mm long.

Hyphal system dimitic; generative hyphae simple septate, thin-walled, brown, 3.1-6 µm wide. Hymenium 5-12 µm thick. Basidia claviform to subglobose, 4.2-7.1 x 4.2-5.2 µm, tetraspored. Basidiospored ellipsoid, hyaline to melleous, with slightly thickened walls, scarce, 3.1-4.2 x 2.6-3.1 µm, inamyloid, indextrinoid, acyanophilous. Setae absent.

MATERIAL STUDIED: Argentina, Misiones, Iguazú Nat'l Park, road to Apepú, leg. Rajchenberg, 8.III.1980, on angiosperm (BAFC 29.453, HOLOTYPE). Ibid., leg. Rajchenberg Wright & Job M-3629, 7.IV.1984 (BAFC 29.861). Ibid., road to Macuco, leg. Job & Rajchenberg M-3591, 6.IV.1984 (BAFC 29.862).

REMARKS: it differs from *Ph. punctatus* in having a very thin, not massive and differently coloured basidiocarp, hyaline and non dextrinoid spores, a dark line in the context, and the typical basidia and cystidia of that species are absent. *Ph. membranaceus* does not fit any of the species described by Murrill (1908) under *Fuscoporia* (hyaline spores and annual fruitbody), or *Fomitiporia* (perennial fruitbody with hyaline spores), nor any of the species described by Ryvarden and Johansen (1980) and Lowe (1960).



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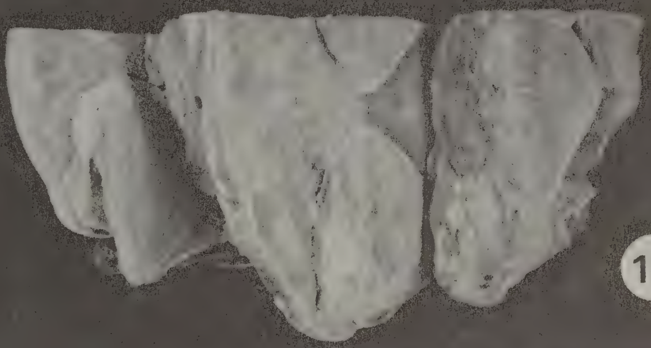

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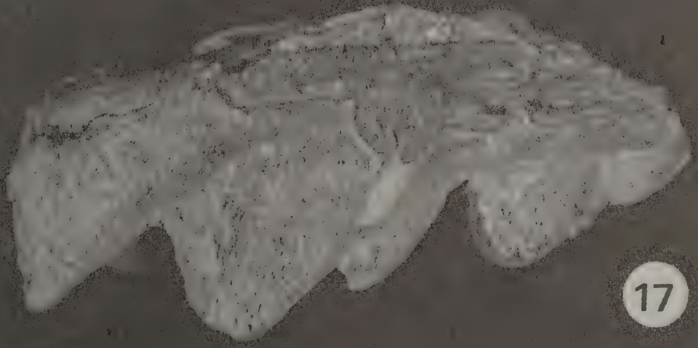

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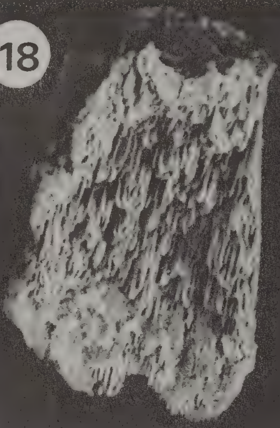
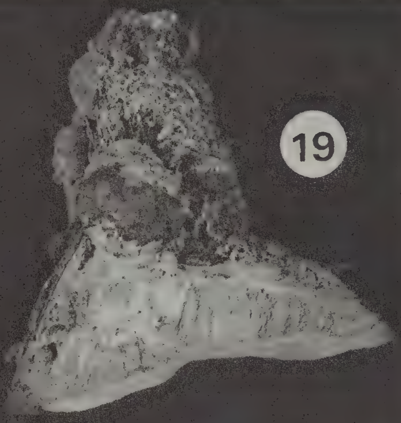
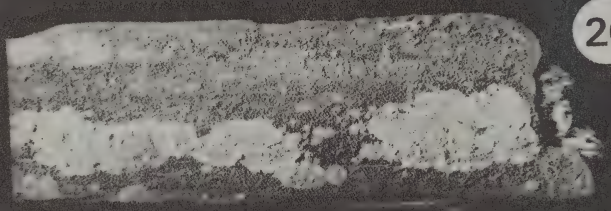
Fig. 15. *Phellinus adhaerens*. Pore surface.

Fig. 16-17. *Phellinus aureobrunneus*. 16, Pileus surface; 17, transversal section of fruitbody showing the tube layer, and the dark line at the base of the context.







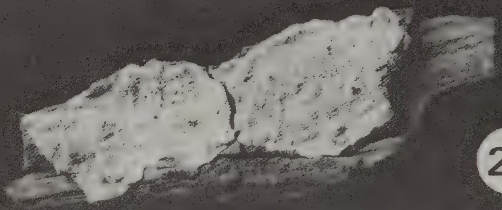


Fig. 18. *Phellinus daedaliformis*. Pore surface.
Fig. 19. *Phellinus elegans*. Aspect of the context and tube layer.
Fig. 20. *Phellinus garuhapensis*. Pore surface.
Fig. 21. *Phellinus membranaceus*. Pore surface.

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PRESENCE EN EUROPE DU *STECCHERINUM OREOPHILUM* (BASIDIOMYCETE) DECRIT D'AMERIQUE DU NORD

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ABSTRACT

The occurence of the American species *Steccherinum oreophilum* Lindsey & Gilbertson in France is affirmed: all pairing between Canadian and French monospermous mycelia are positive. The exsiccata in Bourdot's herbarium (PC) labelled *I. lacteus* subsp. *sinuosus* (Fr.) are actually *S. oreophilum*. Authentic material of *Irpex sinuosus* Fr. represents *I. lacteus*.

RESUME

L'existence en France de l'espèce américaine *Steccherinum oreophilum* Lindsey & Gilbertson est prouvée: les confrontations entre monospermes de souches canadiennes et françaises sont intercompatibles et même interfertiles. Des récoltes de cette espèce ont été retrouvées dans l'herbier de Bourdot (PC) sous le nom d'*Irpex lacteus* subsp. *sinuosus* (Fr.), mais le nom d'*Irpex sinuosus* Fr., ne peut être repris, le spécimen authentique étant un *I. lacteus*.

Dans son ouvrage sur les genres *Irpex* et *Steccherinum* (1974), Maas Geesteranus décrit (p.529) un "Steccherinum sp.I" d'après une récolte faite par J. Boidin sur *Sarothamnus* (LY 4582, les Echets, Ain, France, 24 février 1963) et déterminé par ce dernier *Irpex lacteus* (Fr.:Fr.) Fr. Cette récolte rappelle en effet *Irpex lacteus* par de nombreux caractères: couleur blanche des carpophores, hymenium à dents irrégulières, cystides hyméniales et spores ellipsoïdes. Elle est cependant plus

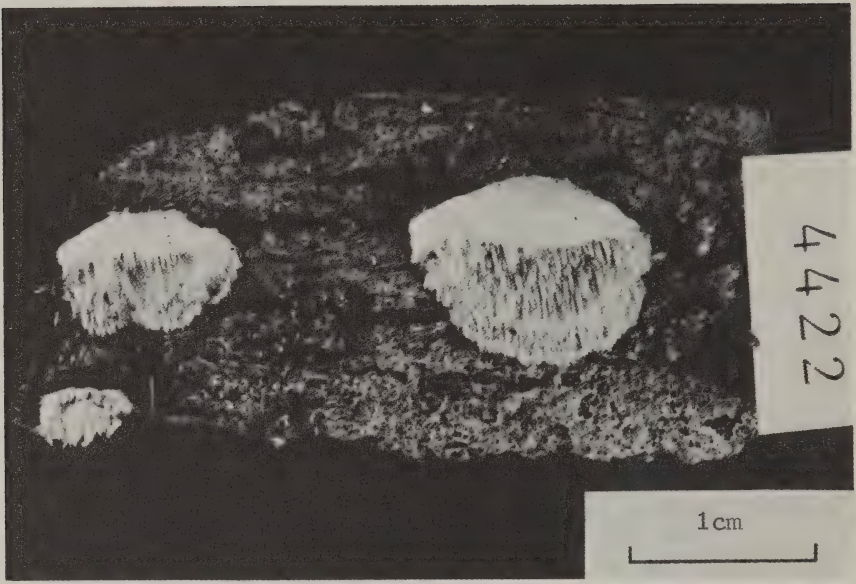

Fig. 1: Carpophore de St. oreophilum sur Sarothamnus scoparius, Forêt de Longuenée, Maine et Loire, France.

tendre et diffère d'Irpex lacteus tel qu'il est actuellement défini par ses hyphes génératrices bouclées; elle est tétrapolaire et présente un comportement nucléaire normal (Boidin et Lanquetin 1965) alors qu'Irpex lacteus sensu Maas Geesteranus est holocénocytique et présumé homothalle (David 1969, sous le nom d'Irpex tulipiferae). Ce Steccherinum "species I" fut recherché sans succès en France pendant plusieurs années puis retrouvé cinq fois de 1982 à 1984: LY-AD 4371 sur tige de Sarothamnus mort debout dans jeune plantation de Picea, Grand Grammond, Haute Vienne, 7-10-1982; 4422 sur Sarothamnus scoparius, Forêt de Longuenée, Maine et Loire, leg. M. Galand, Herbier J. Mornand nº 8307 B2 (photographie); 4433, même lieu, même support que 4371, 23-9-1983; 4468 sur petites branches mortes d'un Populus vivant, bord du lac Ste Hélène, Haute Vienne, 23-9 1983; 4539 sur branchettes de feuillu non déterminé (Salix ?) Pontoux sur l'Adour, Landes, 2-03-1984, leg. G. Gilles. Toutes ces récoltes sont identiques et interfertiles entre elles.

Niemela lors d'un passage à Lyon nous suggéra de la comparer avec une espèce américaine récemment décrite: Steccherinum oreophilum Lindsey et Gilbertson(1977). Des confrontations ont été faites entre monospermes français 4422 1 et 2, 4539 1 et 2 et des monospermes canadiens provenant de la mycothèque de J. Ginns: DAOM 165411 B, on *Tilia americana*, Cantley, Québec. Toutes les confrontations sont positives avec production de fructifications fertiles dans les confrontations 4422 1et 2 x 175411 B 14, ainsi que 4539 1 et 2 x 175411 B 2 et 14. Les récoltes françaises peuvent donc être identifiés au *Steccherinum oreophilum*.

On peut toutefois se demander si cette espèce n'avait pas un nom valide dans des publications antérieures. Bourdot et Galzin décrivent en effet sous le nom d'*Irpex lacteus* subsp. *sinuosus* (Fr.) notre *Irpex* bouclé français précisant que la chair de cette sous espèce est "mince, tendre, plus putrescente que dans *I. lacteus*." Nous avons examiné les exsiccata suivants provenant de l'herbier Bourdot (in PC):n° 5564 sur bourdaine, Forêt de Dreuille, Allier,20-12-1904; 5559 sur *Sarothamnus*, Aveyron, 20-01-1906; 5563 sur tremble, Forêt de Dreuille, Allier 20-12-1904; 6293 sur amélanchier, Causse Noir, Aveyron, 17-04-1908; 16823 sur peuplier, Mas de Barthe, Aveyron, 1-10-1910. Tous les carpophores cités ici ont des hyphes génératrices bouclées et correspondent parfaitement à nos récentes récoltes qui se sont montrées interfertiles avec *Steccherinum oreophilum*. Il nous fallait savoir si l'interprétation de Bourdot concernant *I. sinuosus* était exacte.

Nous avons reçu de l'herbier Fries (UPS) deux collections: *Irpex sinuosus* Fr. Suecia, Ostrogoth.:Rejmyra leg. H. v. Post et *Irpex sinuosus* Fr. Uplandia: Rasbo leg. C.P. Laestadius. Dans les deux cas les carpophores sont constitués d'hyphes génératrices dépourvues de boucles et ne correspondent donc pas à *Steccherinum oreophilum*.

Cette espèce décrite comme montagnarde en Arizona habite la plaine en Europe où elle a certainement une répartition assez large: d'ores et déjà, nous pouvons dire qu'elle existe en Allemagne: sur branche d'*Alnus glutinosa*, réserve naturelle de Fresdorfer Moor, près de Potsdam, DDR leg. D. Benkert, det. G. Ritter. De cette même localité, cinq autres récoltes furent faites par le Dr. Benkert durant les années 1968-1971 sur branches d'*Alnus* et de *Salix*.

Ce champignon que nous avons considéré comme un *Irpex* et que Bourdot et Galzin appellent *Irpex sinuosus* est placé par Lindsey et Gilbertson dans le genre *Steccherinum* où nous l'avons laissé. A la lecture de Maas Geesteranus (1974) la distinction des genres *Irpex* et *Steccherinum* semble se limiter à l'absence de boucles chez *Irpex*, à sa présence chez Steccherinum. La robustesse et l'épaisseur des basidiomes d'Irpex lacteus sont d'autres différences que l'on retrouve chez Irpex flavus Kl. (Irpicodon flavus (Kl) Ryv.) qui se sépare uniquement du précédent par un pigment jaune, la structure et le comportement nucléaire au cours du cycle étant les mêmes.

Nous remercions tous les mycologues qui ont contribué à la clarification de ce problème, soit par l'envoi de carpophores frais (J. Mornand, G. Gilles), de cultures (J. Ginns) ou par le prêt d'exsiccata (G. Ritter, M. Mouchacca et MM. les Directeurs du Laboratoire de Cryptogamie du Museum de Paris et de l'Herbier d'Uppsala), ainsi que T. Niemela pour la lecture critique de ce manuscript.

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GLOMUS DIAPHANUM : A NEW SPECIES IN THE ENDOGONACEAE COMMON IN WEST VIRGINIA[1]

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SUMMARY

A new species of vesicular-arbuscular mycorrhizal fungi, *Glomus diaphanum*, is described which forms abundant soil-borne as well as intraradical hyaline spores characterized by a laminated outer wall and a membranous inner wall. It is most commonly encountered in coal surface minesoils in West Virginia, but also can be found in lesser numbers in agricultural soils. It forms mycorrhizal associations with a wide range of plant species in the field and in pot culture.

INTRODUCTION

A previously unreported *Glomus* species which produced abundant hyaline spores in the soil and in host plant roots was discovered in West Virginia. Spores of this species were numerous in acid soils, particularly surface minesoils, but they also were extracted in low numbers from agricultural soils. This species, herein named *Glomus diaphanum* sp. nov., frequently formed mixed infections with *Glomus occultum* (Walker, 1982).

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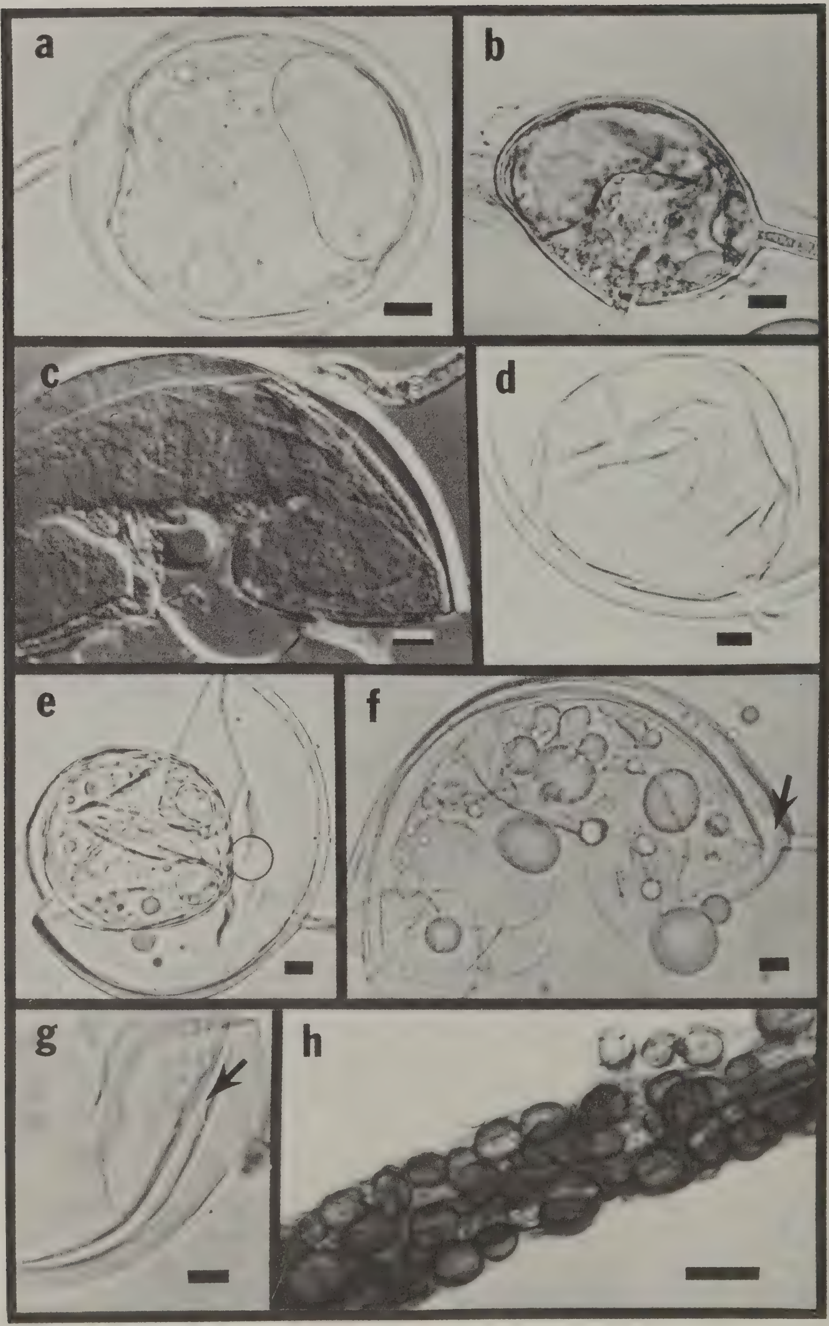
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Since both species were hyaline and of similar size, initial separation into distinct taxa was difficult. However, differences between these two species became readily apparent after each was monocultured on sudangrass [*Sorghum sudanense* (Piper) Staph.], red clover (*Trifolium pratense* L.), corn (*Zea mays* L.), black locust (*Robinia pseudoacacia* Michx.), and fescue (*Festuca arundinacea* Schreb.).

GLOMUS DIAPHANUM Morton et Walker sp. nov. (Figs. 1 and 2)

Sporocarpia ignota. Sporae singulatae vel laxe fasciculatae in solo et confertim fasciculatae in corte radicellae efformatae; hyalinae; globosae, subglobosae (39)-74-(121) um diametro vel ellipsoidae 36-87 x 64-132 um; materia sporae hyalinae. Sporae tunica stratis duobus, separabilis, hyalinae; tunica interiore (0.2)-0.8-(1.3) um crasso et tunica exteriore (2)-4.4-(5.5) um crasso. Hyphae subtendentes (5.4)-8.1-(11.2) um, tunica (1.4)-2.4-(3.7) um crassae ad sporum basum. Mycorrhizae vesicular-arbusculares formans.

Sporocarps unknown. Spores form singly or sometimes as loose clusters in the soil. Commonly, abundant compact clusters of spores form in the root cortex. Spores are mostly globose or subglobose, (39)-74-(121) um in diameter. Ellipsoid spores, which are more frequent in roots, measure 36-86 x 64-132 um. Spores are hyaline under reflected and transmitted light in youth and at maturity. Spore contents are hyaline and consist of one to many oil globules. Spores appear transparent under reflected light when the contents consist of a single large oil globule.

Spore wall structure consists of two walls (walls 1 and 2) in a single group (group A) (see murograph, Fig. 2).

Figure 1. *Glomus diaphanum* a) Intact soil-borne spore. b) Intraradical spore. c) Crushed spore showing both walls and subtending hypha with Nomarski interference light microscopy. d) Intact inner wall remaining inserted into attached hypha. e) Intact inner wall separated from attached hypha. f) Laminae of outer wall splitting into two layers; inner wall broken at point of insertion into attached hypha (arrow). g) Inner wall broken at point of insertion into subtending hypha (arrow). h) Sporulation in the root cortex of sudangrass in pot culture. Bar represents 10 um in a-g, 100 um in h.

Wall 1 is (2)-4.4-(6.5) µm thick, brittle, and finely laminate, breaking into segments when a spore is broken. Wall 2 is closely adpressed, but not adherent, to wall 1, consisting of a thin, membranous wall (0.2)-0.8-(1.3) µm which separates from the outer wall when a spore is crushed and often collapses into loose folds in hypertonic mounting media. Wall 2 extends 5-12 µm into the subtending hypha and forms a septum enclosing the spore contents (Fig. 1e).

Subtending hypha is single, straight or slightly funnel-shaped, (5.4)-8.1-(11.2) µm in diameter at the spore base. The hyphal wall at the point subtending the spore is (1.4)-2.4-(3.7) µm thick. The attached hypha often breaks off at or near the spore base during extraction.

Typical vesicular-arbuscular mycorrhizae form in pot culture. Spores begin forming in the root cortex during peak vesicle development (Fig. 1h). Spores consistently are produced in the roots of different plant species growing in soils with dissimilar physical and chemical properties. However, the proportion of soil-borne to intraradical spores varied depending on soil-host combination (Morton, manuscript in preparation).

DISTRIBUTION AND HABITAT

Glomus diaphanum has been found most commonly in abandoned or partially reclaimed surface coal minesoils which usually are acidic and high in aluminum (Table 2). In some minesoils, spore populations reach 360 spores/gm soil dry weight. This endophyte also was found in pastures, meadows, and in cultivated and no-till corn fields, but in lesser numbers. Most of these soils were moderately to highly acidic before liming and fertilization. Plant hosts and associated VA mycorrhizal fungi at locations where some *G. diaphanum* isolates were

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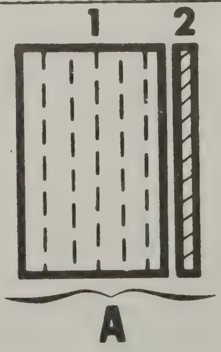

Figure 2. Murograph (Walker, 1983) of *G. diaphanum*. Arabic numerals indicate each wall in order from outer to inner wall; the letter "A" indicates a wall grouping; vertical dashed lines signify a laminated wall, diagonal lines indicate a membranous wall.

collected are listed in Table 1, and chemical properties of those soils are listed in Table 2.

MYCORRHIZAL ASSOCIATIONS

Vesicular-arbuscular mycorrhizae form readily in pot cultures in which spore or root material is used as inoculum. Pot cultures have been established on corn, red clover, subterranean clover (*Trifolium subterraneum* L.) sudangrass, tall fescue, black locust, and with limited success on bigtooth aspen (*Populus grandidentata* L.). Field associations include all of the plant hosts listed above as well as a number of warm-season grasses such as broomsedge (*Andropogon virgnicus* L.) and povertygrass (*Danthonia spicata* Beauv.), which successfully colonize acid soils of marginal fertility (see Table 1).

ETYMOLOGY

Latin, diaphanum; colorless, nearly or quite transparent, referring to the near-colorless appearance of mature spores resulting from a large oil globule filling the spore cavity.

COLLECTIONS EXAMINED

HOLOTYPE: West Virginia, Randolf County, Elkins; from a sudangrass pot culture started with a root/soil mixture sampled from the rhizosphere of red clover on a partially reclaimed coal surface mine (soil #4 in Tables 1 and 2) (Morton, #73 12.xi.83) (OSC). Isotypes (Walker #952) deposited in herbaria at Kew (K) and the Farlow Herbarium (FH).

PARATYPES: Originating from the rhizosphere of corn at the West Virginia University Agronomy Farm (Morton, #27); from red clover (Morton, #6) and black locust (Morton, #230) at the surface coal minesite near Elkins, WV; and from fescue in a pasture near Beckley, WV (Morton, #121) (OSC).

DISCUSSION

Glomus diaphanum forms spores that are consistently hyaline throughout its life cycle. Lack of pigment formation in the spore walls or spore contents is a stable phenotypic characteristic across host species and soil environments. Other taxa which never form pigmented spore

Table 2. Chemical properties of soils in West Virginia containing *G. diaphanum*.

Soil No.	pH (1:1 H_2O)	P (ppm)[a]	K	Ca	Mg	Total Acidity	Al	H	Trace elements (ppm)[d]			
			(meq/100g soil)[b]				(meq/100g soil)[c]		Cu	Fe	Mn	Zn
1	5.85	41.2	3.9	5.0	0.9	0.19	0.16	0.03	0.90	102.0	2.60	1.75
2	4.40	2.5	0.2	1.4	1.1	1.89	1.58	0.31	2.82	71.4	37.78	2.08
3	4.10	2.5	0.2	0.2	0.2	6.18	5.36	0.82	4.28	31.2	34.32	2.22
4	3.70	3.4	0.1	1.3	0.3	4.09	3.52	0.55	0.10	19.3	9.60	4.80
5	4.47	4.7	0.3	1.8	3.0	7.87	7.58	0.30	2.72	94.8	8.40	2.60
6	6.14	62.6	0.5	7.2	0.5	0.10	0	0.10	2.38	55.7	38.85	9.30
7	5.96	14.6	0.3	10.7	1.2	0.07	0	0.07	----	----	-----	----
8	5.62	13.1	0.9	4.4	0.8	0.10	0	0.10	----	----	-----	----

[a] P extracted using 0.5M $NaHCO_3$.

[b] Exchangeable bases determined using 1N $NH_4C_2H_3O_2$ at pH 7.0.

[c] Exchangeable aluminum determined after extraction with 1M KCl

[d] Micronutrients analyzed after DTPA extraction.

Table 1. Field soils containing *Glomus diaphanum*, their plant species composition and associated vesicular-arbuscular mycorrhizal fungi.

Soil No.	Soil history	Plant species	VA mycorrhizal fungi
1	Surface minesoil, upper 15 cm amended with fly ash around 1972.	*Populus grandidentata* Michx. *Festuca arundinacea* Schreb. *Andropogon virginicus* L. *Danthonia spicata* Beauv. *Solidago junceae* Ait.	*Entrophospora columbiana* Spain & Schenck *Glomus occultum* Walker *Glomus clarum* Nicolson & Schenck *Glomus manihotis* Howeler, Sieverding & Schenck *Glomus microcarpum* Tul. & Tul.
2	Abandoned minesoil, over 10 years old.	*Andropogon virginicus* L. *Danthonia spicata* Beauv. *Solidago junceae* Ait. *Aster divaricatus* L.	*Glomus occultum* Walker *Sclerocystis rubiformis* Gerd. & Trappe Undescribed *Glomus*
3	Abandoned minesoil, over 10 years old.	*Andropogon virginicus* L. *Robinia pseudoacacia* L. *Festuca arundinacea* Schreb. *Acer rubrum* L. *Rubus* species	*Glomus occultum* Walker Undescribed *Acaulospora*
4	Partial reclaimed surface stripmine, over 10 years old.	*Festuca arundinacea* Schreb. *Andropogon virginicus* L. *Trifolium pratense* L. *Lespedeza cuneata* G. Don. *Robinia pseudoacacia* L. *Danthonia spicata* Beauv.	*Glomus occultum* Walker *Glomus intraradices* Schenck & Smith *Glomus etunicatum* Becker and Gerd. *Glomus tenue* (Greenall) Hall
5	Lot near school in Morgantown, WV	*Robinia pseudoacacia* L. *Andropogon virginicus* L.	*Glomus occultum* Walker *Glomus clarum* Nicolson & Schenck
6	Corn monoculture for nine years.	*Zea mays* L.	*Glomus occultum* Walker *Glomus etunicatum* Becker & Gerd.
7	Grass-legume pasture	*Trifolium pratense* L. *Festuca arundinacea* Schreb. *Dactylis glomerata* L. *Poa pratense* L.	*Glomus occultum* Walker *Glomus intraradices* Schenck & Smith *Glomus constrictum* Trappe *Glomus geosporum* (Nicol. & Gerd.) Walker
8	Apple orchard for at least 15 years.	*Prunus malus* L. *Festuca arundinacea* Schreb. *Poa pratense* L.	*Glomus occultum* Walker *Glomus microcarpum* Tul. & Tul. *Glomus constrictum* Trappe *Glomus geosporum* (Nicol. & Gerd.) Walker

walls are *Glomus pallidum* (Hall, 1977), *Glomus scintillans* (Rose and Trappe, 1980) and *G. occultum*. *Glomus diaphanum* is distinguishable from these species by the wall structure of its spores (Figures 1 and 2). The thin inner spore wall readily dissociates from the outer wall and resembles the membranous inner walls of some *Acaulospora* and some *Gigaspora* species (Trappe, 1983; Walker, 1983). The inner wall can remain inserted in the attached hypha after separation from the outer wall (Fig. 1d), otherwise detaching intact (Fig. 1e) or breaking off at the point of insertion into the subtending hypha (Fig. 1f-g). Spores of *G. pallidum* produce only a single wall and frequently are formed in sporocarps. *Glomus scintillans* has spores with three walls, the outer wall ornamented with hyaline knobs rather than being smooth.

Glomus diaphanum most closely resembles *G. occultum* when viewed through a dissecting microscope. Both produce hyaline spores of similar size and shape. In field soils, *G. occultum* often is associated with *G. diaphanum* (Table 1). Spore populations of the two taxa are separated readily by swirling the spores in 5% sucrose on a watchglass. *Glomus occultum* spores float whereas *Glomus diaphanum* spores sink. Spore wall structure delimits the two species. *Glomus occultum* has two or three adherent walls whereas *G. diaphanum* has only two walls, an outer laminated wall that is much thicker than the inner membranous wall. In spores collected from some field soils, the outer wall of *G. diaphanum* is more obviously laminate and separated along the boundary of two laminae to give the appearance of two walls of similar thickness (Fig. 1f). This feature was discounted as a genetically stable phenotype, since it could not be reproduced in pot cultures inoculated with spores extracted from these soils.

Spores of other *Glomus* species described as hyaline for part of their life cycle also do not possess the distinctive wall structure of *G. diaphanum*. *Glomus albidum* (Walker and Rhodes, 1981) forms spores of a similar size range to those of *G. diaphanum*, but they possess an evanescent outer wall and a thicker laminated inner wall. *Glomus diaphanum* resembles the smallest of young immature spores of *Glomus clarum* (Nicolson and Schenck, 1979). A mucilagenous roughened outer coat (evanescent wall) and a curved septum in the subtending hypha sealing off the spore contents sometimes can distinguish *G. clarum* spores from those of *G. diaphanum*. However, the thin inner membranous wall and the manner it is inserted into the subtending hypha is diagnostic for *G. diaphanum*.

Glomus lacteum (Rose and Trappe, 1980) forms white rather than translucent or transparent spores. Also, these spores possess only a single wall and usually have more than one subtending hyphae.

Glomus diaphanum forms intraradical chlamydospores in a similar manner to *G. clarum*, *Glomus mannihotis* (Schenck et. al., 1984) and *Glomus intraradices* (Schenck and Smith, 1982). Cleared roots or those stained lightly with 0.05% Trypan blue can be used to separate *G. diaphanum* from *G. intraradices*, the former lacking pigment in the spore walls and the latter having a yellow or brown color. Intraradical chlamydospores of *G. clarum* and *G. mannihotis* can be differentiated from *G. diaphanum* in stained material by the larger and thicker-walled spores which resist the Trypan blue stain in their outer hyaline walls. *Glomus diaphanum* spores stain a darker blue (Fig. 1g).

ACKNOWLEDGMENTS

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Chalara heteroderae, a new species isolated from cysts of **Heterodera glycines** in Illinois

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The successful control of the cereal cyst nematode (**Heterodera avenae** Woll.) in England by fungal parasites (Kerry, 1981) has focused attention on fungi associated with other cyst nematodes. Recent studies in Alabama have shown that the soybean cyst nematode (**Heterodera glycines** Ichinohe) is host to a variety of fungi, including some which are parasitic on nematode eggs (Gintis **et al.**, 1983). We have likewise found numerous fungi associated with cysts of **H. glycines** in Illinois, and in this paper describe a new species of **Chalara**.

The fungus was isolated from **H. glycines** cysts extracted from soybean field soil using a wet sieving technique (Southey, 1970). Cysts were surface-sterilized 3 min in 0.5% NaOCl, rinsed in sterile water, and placed on water agar. Subcultures were made from fungal mycelia growing from cysts. Cultures were maintained on Difco corn-meal agar (CMA) and subjected to fluorescent light (about 10 h daily) or continuous darkness at 22-26 C, or continuous fluorescent light at 20 C. Observations were made on cultures 3-30 da old. Material for fluorescence microscopy was mounted in 0.5% Calcofluor and viewed as described earlier (Glawe, 1984).

Chalara heteroderae, sp. nov. Figs. 1-17.

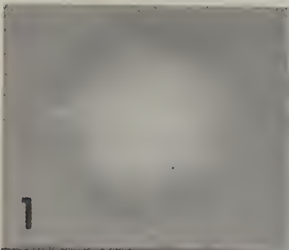
Coloniae super agarum cum farina ex zea compositum crescentes die octava 2.8-5.8 cm diametro, albae, centro laneo, denso, marginem versus effusae. Cellulae conidiogenae e cellulis lateralibus, sphaeroidalibus vel ex hypharum lateribus ortae, nonnumquam terminales, subcylindricae vel lageniformes, haud distincte inter ventrem et collarulum definitae, (12.7-)19.3-35.8 X 2.8-5.5(-7.2) µm. Conidia hyalina, continua, tenuiter tunicata, dimorpha, vel cylindrica, utrinque truncata, 6.6-11.6(-16.5) X 2.8-4.4 µm, vel inter formam ellipsoidalem, globsam, et pyriformem variantia, 5.0-12.7 X 3.3-8.8(-12.0) µm.

Eight-da-old colonies on CMA (Fig. 1) 2.8-5.8 cm diam, white, center woolly, dense, effuse toward margin; reverse coloration white. Mycelium superficial and immersed, hyphae septate, hyaline, smooth or verruculose (Fig. 6), 2-5 µm diam. **Conidiogenous cells** arising usually from lateral spheroidal cells (Figs. 2, 3), or laterally from hyphae (Fig. 4) or sometimes terminally; subcylindrical to lageniform, with transition from venter to collarette gradual and lacking clear demarcation, often with periclinal thickenings (Figs. 7, 8, 14), (12.7-)19.3-35.8 µm in length, 3.3-5.5(-7.2) µm wide at venter, 2.8-3.9 µm wide at apex. **Conidia** extruded singly or in chains; dimorphic, either cylindrical with truncate or rounded ends (Fig. 12) or ranging from ellipsoidal or globose to pyriform (Figs. 9-11); hyaline; unicellular; walls smooth and thin; end walls fluorescing brightly (Fig. 17); cylindrical conidia 6.6-11.6(-16.5) X 2.8-4.4 µm; conidia of other shapes 5.0-12.7 X 3.3-8.8(-12.0) µm.

Isolates examined: HOLOTYPE: Carris no. S-7-16-4, 9.X.1983, dried culture and slides deposited in ILLS (accession no. 44302), living culture deposited with ATCC; Carris no. S-4-20-4, 5.VIII.1983; Carris no. S-4-C-6, 5.VIII.1983; all isolates obtained from cysts of **Heterodera glycines** from soil of soybean field near Sidney, Champaign Co., Illinois.

This is the second species of **Chalara** isolated from cysts of **H. glycines**. **Chalara hyalina** Morgan-Jones & Gintis (Morgan-Jones **et al.**, 1984) differs from **C. heteroderae** in forming only cylindrical conidia and lacks the conspicuous spheroidal cells which often subtend conidiogenous cells in **C. heteroderae**. Both species produce verruculose hyphae, as do several other **Chalara** species (Nag Raj and Kendrick, 1975).

Figs. 1-6. **Chalara heteroderae.** 1. Eight-day-old colony, X0.75. 2, 3. Conidiogenous cells subtended by spheroidal cells. 2, X770. 3, X2500. 4. Conidiogenous cell produced directly from hypha, X770. 5. Conidiogenous cell with globose and cylindrical conidia, X770. 6. Verruculose hypha, X2500. Fig. 1 by photomacrography, others by differential interference contrast microscopy. All magnifications approximate.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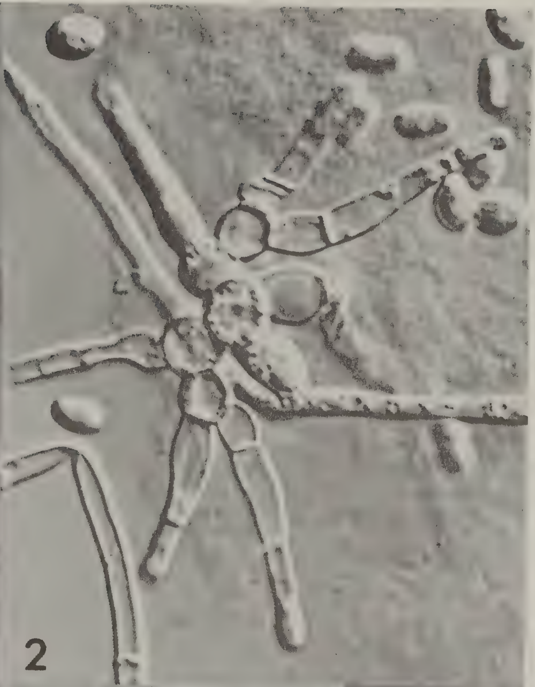
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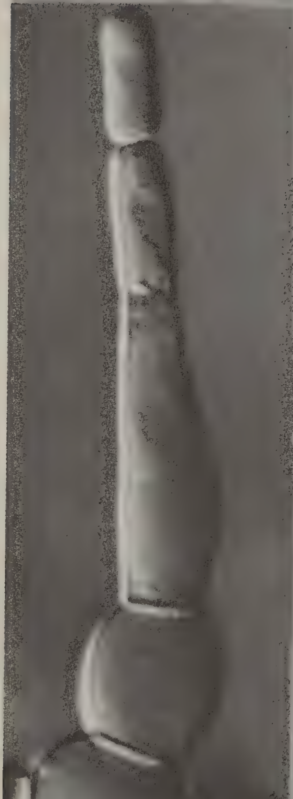
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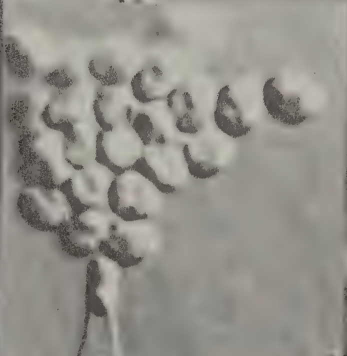
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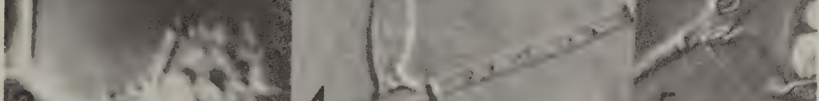
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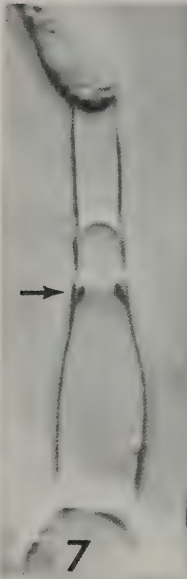
The variation in conidial size and shape is the most distinctive feature of **C. heteroderae**, with cylindrical and ellipsoidal to globose conidia being formed more or less regularly in cultures of all ages. Single conidiogenous cells often produce conidia of several different shapes. **Ceratocystis adiposa** (Butl.) C. Moreau, **C. autographa** Bakshi, and **C. fimbriata** Ell. & Halst. also produce enteroblastic, dimorphic conidia. In those species, however, the non-cylindrical conidia are pigmented and/or thick-walled, and often are ornamented. Conidia of **Chalara heteroderae** remain hyaline and thin-walled at maturity. **Chalara heteroderae** often produced globose conidia at conidiogenous cell apices, while cylindrical conidia were produced deep within conidiogenous cells. Conidial chains sometimes included both globose conidia, which tended to be outside but not within phialides, and cylindrical conidia which could be found outside or within conidiogenous cells (Figs. 5, 15, 16). Pyriform conidia often were seen with only the narrow bases extending into conidiogenous cells (Fig. 10). These observations suggest that cylindrical conidia result when developing conidial walls become set while conforming to the cylindrical shape of conidiogenous cells, and that globose conidia can result when extruded conidia expand unconfined by conidiogenous cell walls.

The production of conidia at the apices of conidiogenous cells or at varying depths within them suggests that the conidiogenous locus might not be fixed in **Chalara heteroderae**. In this respect it resembles **Ceratocystis adiposa** which lacks a fixed conidiogenous locus (Hawes and Beckett, 1977a). Cells of **Chalara heteroderae** sometimes fluoresced brightly in ring-shaped regions (Figs. 13, 14) resembling those demonstrated in fungi with similar phialides (Hawes and Beckett, 1977a, b; Glawe, 1984). These observations suggest that conidial wall synthesis proceeds in the same manner in all of these species. Periclinal thickenings apparently have not been reported previously in **Chalara**, but are common in **C. heteroderae** and occur in the **Chalara**-like **Fusichalara**

Figs. 7-12. **Chalara heteroderae.** 7, 8. Conidiogenous cells with periclinal thickenings (arrows), X2500. 9. Globose conidia, X2500. 10. Pyriform conidium (arrow) extending from apex of conidiogenous cell, and cylindrical and globose conidia, X2500. 11. Globose conidia, one with loosened outer wall layer (arrow), X2500. 12. Cylindrical conidia, X2700. All by differential interference contrast microscopy. All magnifications approximate.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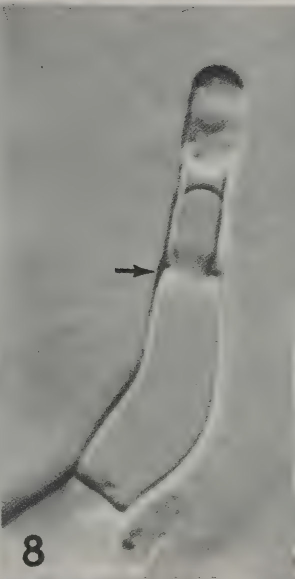
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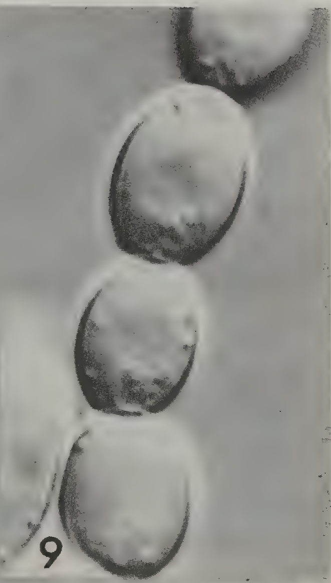
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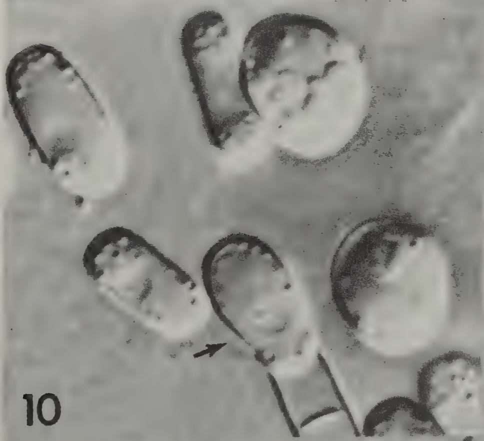
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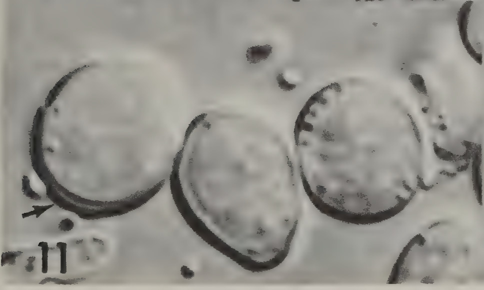
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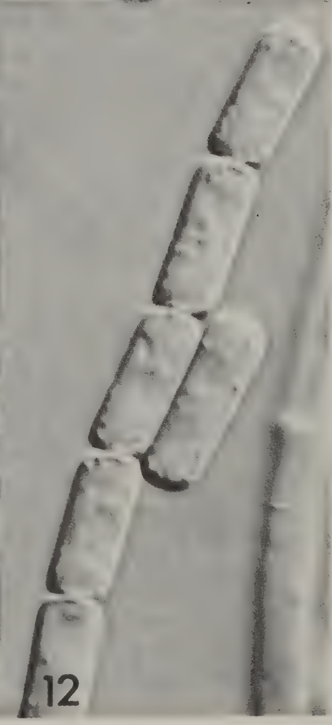
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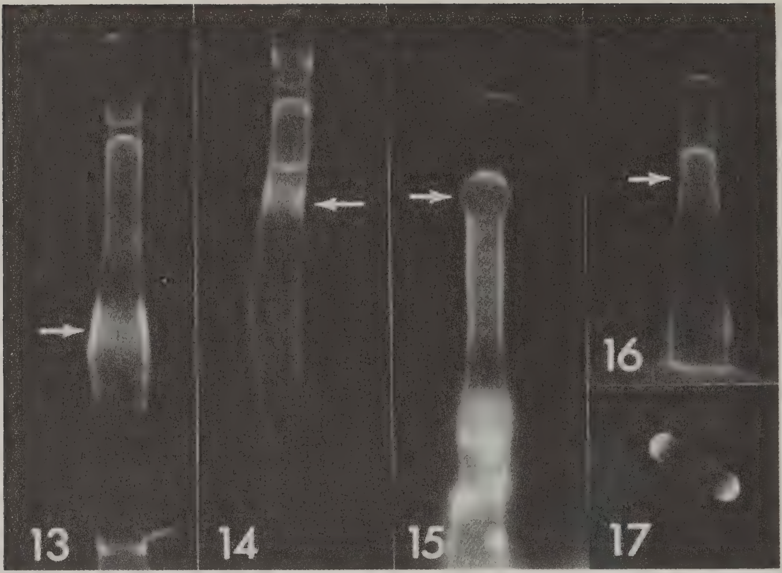

Figs. 13-17. **Chalara heteroderae.** 13. Conidiogenous cell with ring-shaped zone of fluorescence (arrow). 14. Conidiogenous cell with ring-shaped zone of bright fluorescence at site of periclinal thickening (arrow). 15. Conidiogenous cell with cylindrical conidium and incipient globose conidium (arrow). 16. Conidiogenous cell with partially formed cylindrical conidium. 17. Conidium with brightly fluorescing end walls. All **ca.** X1600. All material mounted in Calcofluor, viewed by fluorescence microscopy.

clavatispora Kirk (Kirk and Spooner, 1984). Minter **et al.** (1983) believed that periclinal thickenings result from production of "false chains" of conidia. **Chalara** species, however, generally are believed to produce conidia in "true chains" (Cole and Samson, 1979; Minter **et al.**, 1983). Therefore, the periclinal thickenings possibly could be interpreted as evidence that **C. heteroderae** produces false chains of conidia. This interpretation would be supported by our inability to demonstrate a continuous, outer conidial wall of the type which connects conidia in true chains (Minter **et al.**, 1983), or basal conidial frills such as were interpreted as possible remnants of a continuous wall layer in **Bloxamia truncata** Berk. & Br. (Glawe, 1984). However, a continuous conidial wall layer that is too thin to be resolved with light microscopy might exist in **C. heteroderae**; the ring-shaped zones of fluorescence in conidiogenous cells indicate that such may be the case (see also Glawe, 1984). Some globose conidia in old cultures had loosened outer wall layers (Fig. 11) which might represent the remnants of a continuous conidial sheath. Another problem is that periclinal thickenings by themselves cannot be viewed as irrefutable evidence of false chain conidial ontogeny, since **Aspergillus clavatus** Desm., which produces true chains of conidia, sometimes produces periclinally thickened phialides (Minter **et al.**, 1983). Minter **et al.** (1983) suggested that periclinal thickenings in **A. clavatus** might result from discontinuous conidial production, as when a diurnal cycle of lighting promotes periodically interrupted conidiogenous activity. We tested the possible influence of light on formation of periclinal thickenings in **C. heteroderae** by culturing it under continuous light and constant temperature, continuous darkness, and alternating light and darkness. The fungus produced periclinal thickenings in each instance, even though cultures maintained in darkness produced fewer conidia than those in light. Thus, there is no evidence that periclinal thickenings in **C. heteroderae** result from discontinuous conidial production caused by intermittent lighting. It is not possible to state whether **C. heteroderae** produces true chains of conidia, false chains, or both. Further research, especially at the ultrastructural level, will be needed to establish more clearly the kind or kinds of conidial ontogeny operating in this fungus, and the developmental and taxonomic significance of periclinal thickenings in phialides.

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A NEW SPECIES OF **CRUCELLISPORIOPSIS** FROM INDIA

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INTRODUCTION

The genus **Crucellisporiopsis** Nag Raj was recently erected for two coelomycetous anamorphs having tetraradiate conidia arising from percurrently proliferating phialides (Nag Raj, 1982). A previously undescribed anamorph has been collected on an unidentified decaying angiosperm leaf from India. This fungus has been found to fit the generic concept of **Crucellisporiopsis** and is described and illustrated in the present paper.

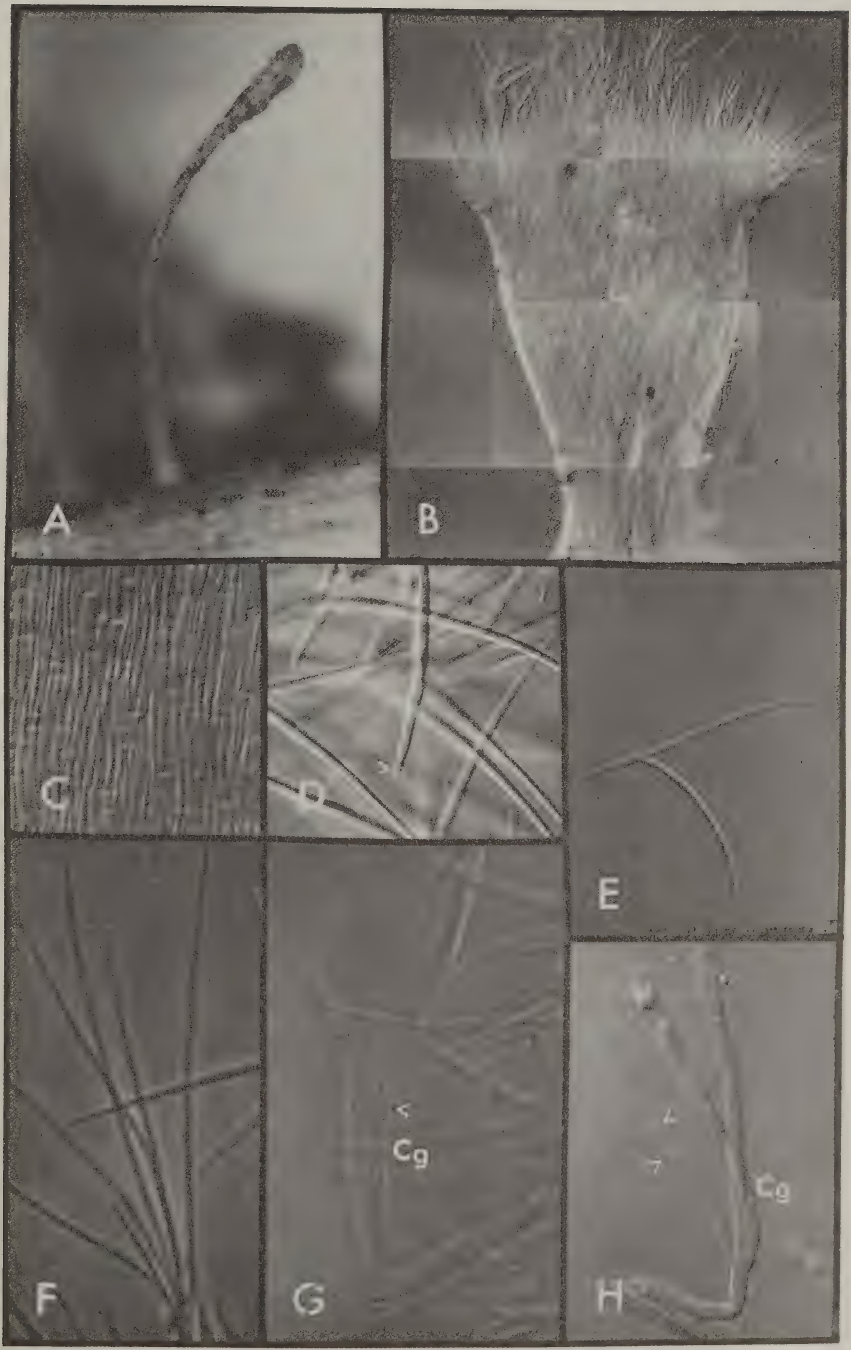
TAXONOMIC PART

Crucellisporiopsis prolongatus anam. sp. nov.
Fig.1-8.

Foliicola. Conidiomata erumpentia, dissita ad gregaria, recta vel curva,

claviformia, 1.0 - 2.5 mm longa, straminea, leniter scabra; ex uno capitulo et stipite constantia; stipes subcylindricus, ad basim paulum amplitur, (usque ad 150 um lat.) versus apicem decrescens (usque ad 50 um lat.); capitulum ellipticus, saepe apice acuto, e hyphis sterilibus aperturam apicalem cingentibus, 500-1000 X 80-140 um; hyphae stipitem et excipulum continuae, subhyalinae vel hyalinae; excipulo hyalino, e textura porrecta composito; hymenium conidialis hyalinum,ex textura prismatica ad textura angulari compositum. Conidiophora cavitatem conidiomatis exorientia, septata, hyalina, laevia, in 1-3 (plerumque 2) cellulis conidiogenis vel hyphis sterilibus terminantia. Hyphae steriles rectae vel flexae, usque ad 190 um long., ad basi 1.5 um lat., superne ad 2 um lat. dilatatae, tum ad apicem decrescentes ad 1 um lat.; cellulae conidiogenae phialides, teretiae vel subcylindricae, hyalinae, laeviae, (12-) 17 (-26) X (1.0-) 1.6 (-2.0) um, usque ad ter percurrenter prolificantes. Conidia blastico-phialidica, tetra-radiata (raro penta-radiata), hyalina, laevia, guttulata; axis principalis clavatus ad obconicus, ad basim augusto-truncatis, septo uno, cellulis inaequalis, (14-) 17 (-21) um long., basim 1-2 um lat., apicem 2-4 um lat., cum base unam simplicem, attenuatam, tubularem appendicem usque ad 3 um long. ferens; brachia 3 (raro 4), apicem axis principalis ad ali loci inserta, divergentia, e axe principali septiis

Fig. 1. **Crucellisporiopsis prolongatus** ex type in DAOM 187814; A, Macroscopic view of conidioma. X40. B, Composite optical section through conidioma. X160. C, Textural detail of excipulum. X625. D, Conidium. X575. (arrow marks appendage). E, Conidium X450. F, Sterile hyphae. X520. G, Conidiogenous cell bearing conidium. X1200. (arrow marks percurrent proliferation). H, Conidiophore showing percurrent proliferations (arrows). X1000. (conidia have been damaged). (F) taken with phase contrast, all others with DIC illumination.


A
B
C
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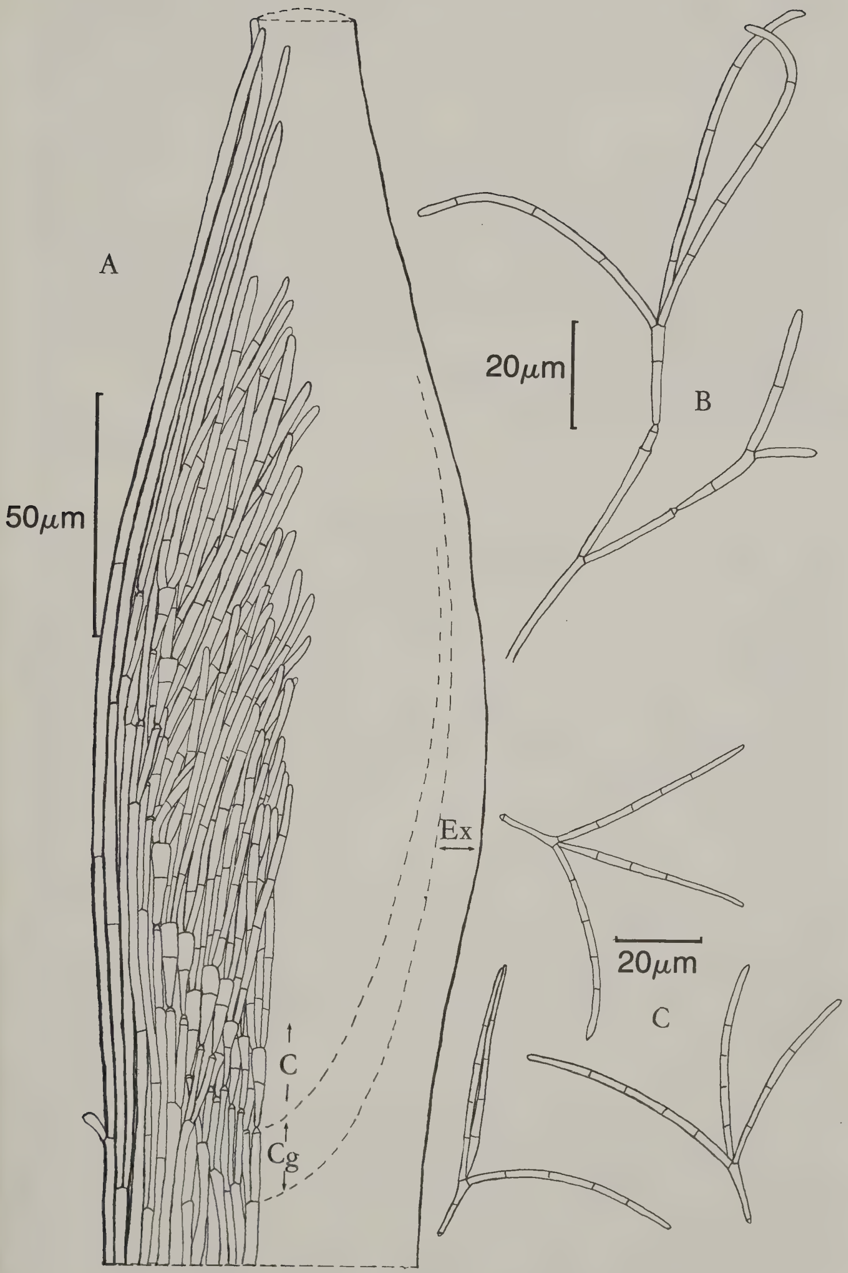
H
Cg

sejuncta, attenuata, flexuosa, 3-5 (plerumque 4) septata, sine constrictione ad septa, inaequalia, (31-) 53 (-83) X 1.5-2.0 um.

Foliicolous. **Conidiomata** erumpent, scattered to gregarious, more or less erect or curved, claviform, 1.0 - 2.5 mm tall, straw-coloured, slightly roughened. Conidioma differentiated into a head and a stalk; stalk subcylindric, slightly enlarged and up to 150 um wide at the base, narrowing to 50 um above; head ellipsoidal, 500-1000 X 80-140 um, often with a pointed tip formed by sterile hyphae surrounding an apical opening which leads into a hymenium-lined cavity; hyphae of stipe and excipulum continuous, subhyaline to hyaline; hyaline excipulum of **textura porrecta**; hymenium of **textura prismatica** to **textura angularis. Conidiophores** arising in the concavity of the conidioma, septate, hyaline, smooth-walled, branched, terminating in (1-) 2 (-3) conidiogenous cells or sterile hyphae. **Sterile hyphae** straight or curved, with an obtuse apex, septate, hyaline, smooth-walled, up to 190 um long, 1.5 um wide at base, widening to 2 um then tapering to 1 um at the apex. **Conidiogenous cells** phialides, terete to subcylindrical, hyaline, smooth-walled, (12-) 17 (-27) X (1.0-) 1.6 (-2.0) um, with up to 3 percurrent proliferations. **Conidia** blastic-phialidic, tetra-radiate (rarely penta-radiate), hyaline, smooth-walled, guttulate; main axis clavate to obconic, with a narrow truncate base, 1-septate with unequal cells, (14-) 17 (-21) um long, 1-2 um wide at base, 2-4 um wide at apex, bearing a simple, attenuated, tubular appendage up to 3 um long

Fig. 2. **Crucellisporiopsis prolongatus** ex type in DAOM 187814; A, Outline of conidioma with details of excipulum (Ex.), conidiogenous cells (Cg.), and conidia (C.) drawn on left half. B, Conidiophore with developing conidia. C, Mature conidia.


A
50µm
20µm
B
Ex
C
Cg
20µm
C

at the base; arms delimited from main axis by septa, attenuated, curved; each arm (3-) 4 (-5) -septate, without constrictions at septa, arms unequal in length, (31-) 54 (-83) X 1.5-2.0 um.

HABITAT: On decomposing leaf of an unidentified angiosperm.
SPECIMENS EXAMINED: HOLOTYPE: DAOM 187814 (also held in PAN 9043); along banks of stream,in predominantly pine forest, Dharmpur, Solan, Himachal Pradesh, India, 6000 ft; collected by G.S. Rawla, August, 1978.
KNOWN DISTRIBUTION: India
TELEOMORPH: Unknown

DISCUSION

The slender, stalked conidiomata of this fungus initially suggested that it was a synnematal hyphomycete. The formation of conidia inside a well-developed pycnidioid cavity, however, clearly places it among the coelomycetes. **Corniculariella** Karsten char. emend. DiCosmo is a good example of a group of pycnidial coelomycetes which have previously been described and illustrated (DiCosmo, 1978). Michaelides et. al. (1982) have described the synnematal hyphomycete, **Ulocoryphus mastigophorus**, in which a concave hymenium lies within a sheath of fused hyphae. They suggest that the hyphal sheath may represent an excipulum and the hymenium a future pycnidial cavity, and that the conidioma may be evolving toward (or away from) the pycnidial condition. **Conicomyces transvaalensis** Sinclair, Eicker and Morgan-Jones has been described as a synnematous hyphomycete (Sinclair et. al., 1983) despite the presence of a well-developed pycnidioid cavity. While the distinction between synnematal hyphomycetes and stalked pycnidial coelomycetes is open to a certain degree of subjective interpretation, **Conicomyces transvaalensis** would seem to be more appropriately described as a coelomycete than as a hyphomycete. The close resemblance between **Conicomyces** and **Morrisographium** Morelet (see illustration in Morris, 1966) suggests that there may be a gradation between the synemmatal hyphomycete and the coelomycetous habit in these fungi, however it is not clear from the illustration that **Morrisographium** is indeed synemmatous and not a pycnidial coelomycete. An anatomical study of **Morrisographium** is obviously required.

The shape of the conidioma of **Crucellisporiopsis prolongatus** distinguishes it from the species for which the genus **Crucellisporiopsis** was established, the type species being acervuloid and the other species being sessile to short-stalked (Nag Raj, 1982). However, the presence of sterile hyphae, and the production of tetraradiate conidia by percurrently proliferating phialidic conidiogenous cells arising from branched conidiophores made it unnecessary to erect a new genus simply to accommodate the stalked conidioma of this fungus. Instead, a minor expansion of the generic concept of **Crucellisporiopsis** to include stalked conidiomata is proposed. The present fungus fits easily into such an expanded generic concept.

A brief summary of the distinguishing features of each of the three species of the newly enlarged genus **Crucellisporiopsis** is given in Table 1.

The conidia of the genus **Crucellisporiopsis** and of two other related coelomycetous genera, **Eriosporella** Hohnel and **Crucellisporium** Farr (Nag Raj, 1982) closely resemble those of several genera of amphibious hyphomycetes such as **Isthmotricladia** Matsushima (Matsushima, 1971) and **Tridentaria** Preuss (Matsushima, 1975; Webster and Descals, 1981). Although there can be no confusion between these genera and the aquatic genera if the conidioma have been found, it would be considerably more difficult to make an identification on the basis of a collection of conidia only. It is therefore important that those working with amphibious hyphomycetes be aware of those coelomycetes bearing tetraradiate conidia.

Table 1 COMPARISON OF SPECIES OF **CRUCELLISPORIOPSIS**

C. cymbionoides	**C. gelatinosus**	**C. prolongatus**
apothecioid, short, wide stipe	acervuloid	urceolate, tall, narrow stipe
sterile hyphae straight or flexous	sterile hyphae irregularly coiled	sterile hyphae straight or flexous
conidia tetraradiate	conidia tetraradiate, occasionally pentaradiate	conidia tetraradiate, rarely pentaradiate
basal appendage lacking	conidia with basal appendage	conidia with basal appendage

Descals and Webster (1982) have noted that some recently described amphibious fungi show 'strong similarities with terrestrial and dematiaceous hyphomycetes and coelomycetes.' Here we have described another coelomycete with conidia similar to those of amphibious hyphomycetes. Noting that **C. prolongatus** was collected along the banks of flowing water, it is interesting to speculate that there may be some ecological or taxonomical connection between terrestrial and aquatic fungi that bear tetraradiate conidia.

ACKNOWLEDGMENTS

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BRASILIOMYCES, A NEW HOST FOR AMPELOMYCES

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ABSTRACT

Pycnidia of *Ampelomyces quisqualis* have been discovered parasitizing ascocarps of *Brasiliomyces malachrae* and conidia and conidiophores of *Oidiopsis gossypii* growing on cotton in west-central Venezuela. This is the first report of this fungus occurring on *Brasiliomyces*.

RESUMEN

Se describen pycnidios de *Ampelomyces quisqualis* parasitando ascocarpos de *Brasiliomyces malachrae* y conidios y conidióforos de *Oidiopsis gossypii* que crecen en algodón de la zona Centro Occidental de Venezuela. Este es el primer informe de este hongo en el genero *Brasiliomyces*.

Species of the pycnidial genus *Ampelomyces* are common parasites of powdery mildew fungi, occurring on both the teleomorphic and anamorphic states. They are worldwide in distribution and apparently occur wherever the hosts are found. According to Hawksworth (1981), *Ampelomyces* has been reported on species of *Erysiphe, Microsphaera,* *Phyllactinia, Sphaerotheca,* and *Uncinula* and their anamorphs. Other reported hosts are *Podosphaera* (Galloway, 1889) and *Leveillula* (Venkatarayan, 1946). This paper reports a new host genus for *Ampelomyces.*

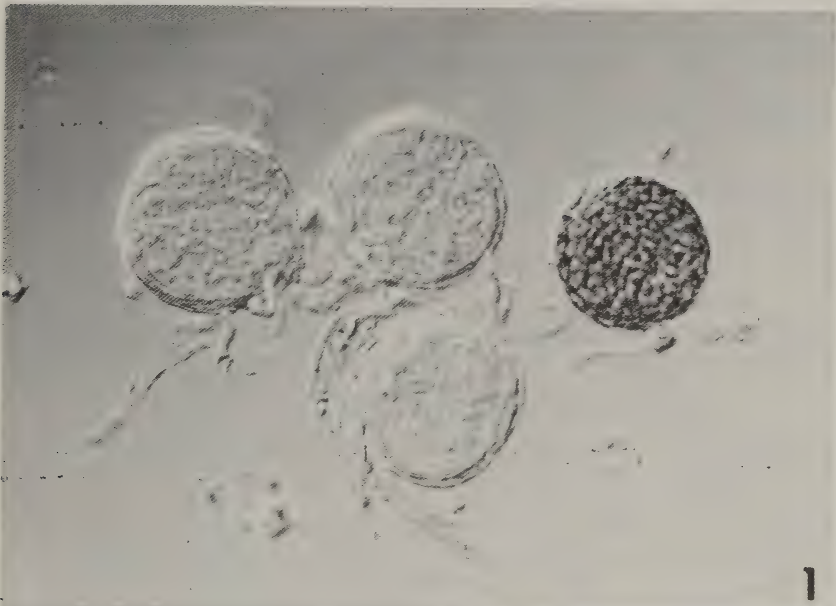
Recent collections of a powdery mildew infecting cotton (*Gossypium barbadense L., G. hirsutum L.,* and *G. purpurascens* Poir.) in Venezuela have been identified as *Brasiliomyces malachrae* (Seaver) Boesewinkel (Hanlin and Tortolero, 1984a), a seldom-reported tropical member of the Erysiphaceae. While examining these collections a number of ascocarps infected with pycnidia of *Ampelomyces* were discovered (Fig. 1, 3). The majority of the pycnidia were globose, taking the shape of the infected ascocarps. The pycnidia were dark brown and averaged 61μm high X 59μm wide; they contained numerous one-celled, hyaline, oval conidia (Fig. 2) that averaged 11μm long X 4.9μm diam (10-15 X 3.75-5μm). These characteristics conform to the description of *A. quisqualis* Ces. ex Schlecht (=*Cicinnobolus cesatii* deBary) (Sutton, 1980).

In addition to ascocarps of *Brasiliomyces malachrae, Ampelomyces* pycnidia were also found parasitizing conidiophores and conidia of *Oidiopsis gossypii* (Wakefield) Raychaudhuri, a second powdery mildew growing on the same cotton leaves (Hanlin and Tortolero, 1984b). Pycnidia formed on this host were more fusoid to elongate (Fig. 4, 5) than those infecting ascocarps. They averaged 81μm long X 36μm diam (50-125 X 30-47μm).

Clare (1964) has suggested that pycnidial shape in *Ampelomyces* often conforms to the shape of the structure infected, and this is clearly indicated in our material.

Several studies have been conducted on the infection process and subsequent pycnidium development in powdery mildews by *A. quisqualis.* Emmons (1930) demonstrated that hyphae of the parasite grow internally in the hyphae of the

Figs. 1-5. *Ampelomyces quisqualis.* Nomarski optics. 1: Pycnidium in ascocarp of *Brasiliomyces malachrae* (right); three uninfected ascocarps at left. X400. 2: Mature conidia. X800. 3: Close-up of infected ascocarp in Fig. 1. Note basically attached hyphae typical of ascocarps. X680. 4: Pycnidium on conidiophore of *O. gossypii.* X520. 5: Pycnidium developing in apex of conidiophore and base of conidium of *O. gossypii.* Note hypha of parasite growing inside conidium. X550.



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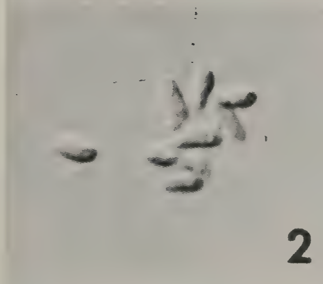

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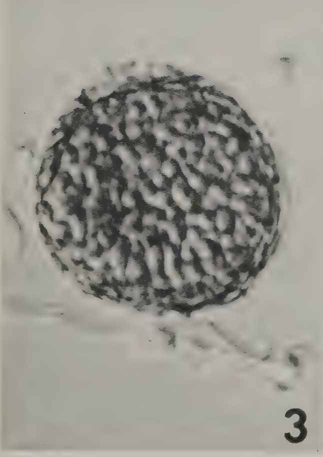

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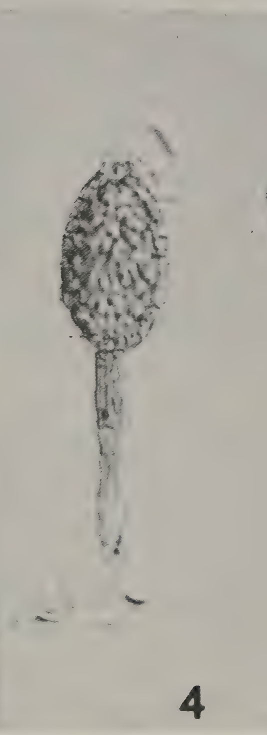

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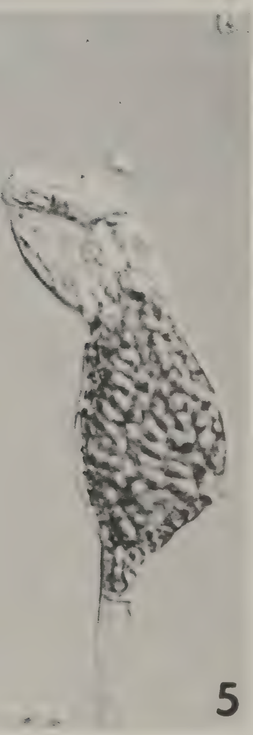

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host (*Erysiphe cichoracearum*) and produced pycnidia in both ascocarps and the *Oidium* anamorph. More recent studies with the electron microscope have confirmed and expanded these observations (Hashioka and Nakai, 1980; Sundhein and Krekling, 1982).

It thus appears that infection of powdery mildews by *Ampelomyces* is universal, regardless of their host or where they occur.

ACKNOWLEDGMENTS

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ENTOMOPHTHORA ISRAELENSIS SP. NOV. [ZYGOMYCETES: ENTOMOPHTHORALES], A FUNGAL PATHOGEN OF GALL MIDGES [DIPTERA: CECIDOMYIIDI]

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SUMMARY

Entomophthora israelensis sp. nov. (Zygomycetes: Entomophthorales) was discovered in dead gall midges (Diptera: Cecidomyiidi) on young grapefruit and orange leaves, in Israel. The fungus possesses all the generic level characters of the genus *Entomophthora* sensu stricto. Its specific level characters are compared with those of all published and some unpublished species of *Entomophthora* s.str. Two characters used before only at the generic level are considered here as very useful at the specific level in plurinucleate genera of Entomophthorales: the number and size of nuclei in conidia, conidiophores, and hyphal bodies.

FIELD CHARACTERS

At the end of September 1983, while surveying for Entomophthorales attacking citrus pests in Israel, a number of unidentified gall midges, ca. 1.5mm long, were found dead on young citrus leaves. Microscopic examination of the dead midges (Fig. 1) revealed the cause of death: an entomophthorosis resembling very closely *Entomophthora culicis* (A.Braun) Fres. Conidial measurements and nuclear staining with acetocarmine showed that despite superficial resemblance, the causal agent was an undescribed species of Entomophthoraceae.

Additional data about the disease were gathered during a close follow-up. Dead midges were found only on grapefruit and orange trees, and only on young leaves which attained mature size but were still softer, had a lighter green color, and had a stronger citrus flavour than mature ones. By the end of the second week of October fresh specimens could no longer be found. Decaying specimens were still present, covered with Cladosporium and Alternaria spp.

On freshly dead midges conidiophores appeared between the abdominal segments, and had a light cream color. In more advanced stages the conidiophores coalesced over the entire abdomen, leaving the thorax and head uncovered. After sporulation was completed the mass of conidiophores became orange, changing to brown in later stages. At the "orange" stage the central dorsal part of the abdomen became visible as a dark dot, meaning that this part was merely covered by coalesced conidiophores, but not penetrated by them from within. Freshly dead midges were fixed to the leaves by monohyphal rhizoids protruding among their mouth parts, while their abdomens rested parallel to the leaf surface, without touching it; the wings were held in an upright position (Fig. 1a). In later stages the abdomens descended to touch the leaf and became attached by monohyphal rhizoids protruding from the abdominal tip. Finally, the whole insect was spread flat on the leaf surface with wings resting at close to right angles relative to the body (Fig. 1b).

Specimens were found singly or in numbers of no more than 4 per leaf, but occupied approximately every second leaf of the proper age group. Other Entomophthorales present in the same orchard simultaneously were Neozygites

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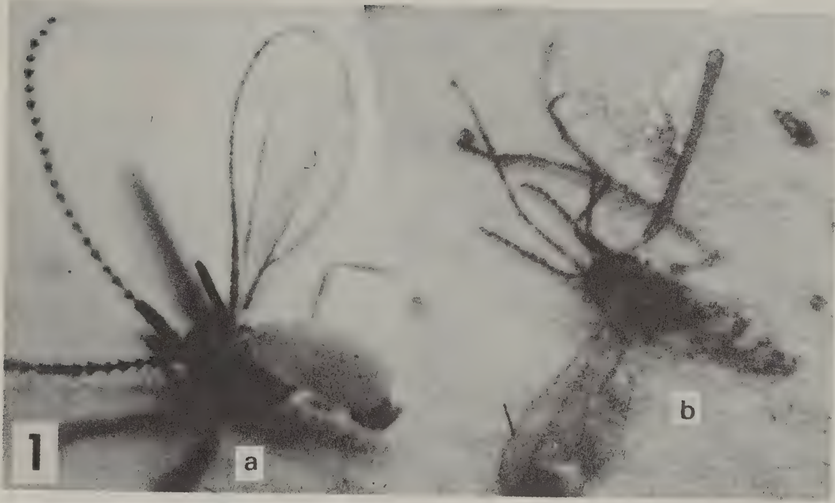
Figs. 1-4: Entomophthora israelensis sp.nov. on cecidomyiid midges. 1a. Characteristic position of freshly dead midge with wings erect; the abdomen, covered by coalesced conidiophores, does not touch the leaf (approx. X 30). 1b. Post-conidiation position of dead midge, completely collapsed on leaf surface (approx. X 20). 2. Primary conidia showing 3 - 4 nuclei (acetocarmine, X 1000). 3. Secondary conidia, the lower one showing 3 nuclei and a papillar vacuole (acetocarmine, X 1000). 4. Immature conidiophores showing nuclei (acetocarmine, X 1000).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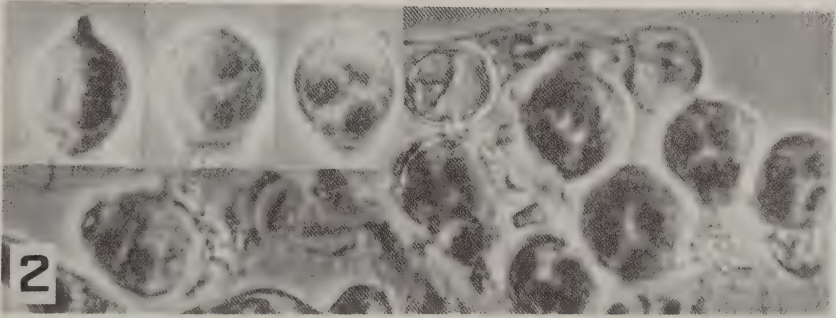
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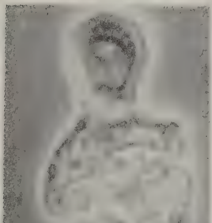
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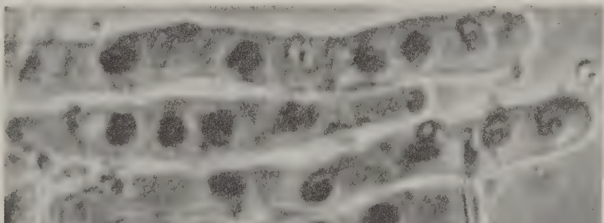
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fresenii (Nowak.) Remaudière & Keller, on Aphis citricola, and Erynia radicans (Brefeld) Humber et al. on Empoasca sp. (lybica complex).

DESCRIPTION

ENTOMOPHTHORA ISRAELENSIS BEN-ZE'EV & ZELIG, SP.NOV. (Figs. 1-7). Conidia primaria hyalina, truncato-campaniformia [secundum Lakoni (1919) systema] basi brevi et apice apiculata (vel papillata), 15.0-19.8 X 11.0-15.8 µm, med. 16.7 X 13.0 µm, violenter emissa et guttula protoplasmica circumdata, tri- ad quinquenucleata. Conidia secundaria similia, sed minora et apice rotundata, raro papillata, 12.6-16.0 x 11.0-12.6 µm, med. 14.2 x 11.6 µm, violenter emissa sine guttula protoplasmica. Conidiophora primaria plus minusve cylindrica et apice clavata, unicellulata, tri- ad sexnucleata, raro ad octonucleata. Segmenta hyphalia subsphaerica vel pyriformia vel allantoidea. Rhizoidea filiformia, unihyphalia, simplicia. Pseudocystidia absentia. Sporae perdurantes non observatae. In Super-Tribu Cecidomyiidorum (Dipterorum), imagines, Bet-Oved, Israel, Sept.- Oct. 1983.

Primary conidia are spheroidal with a short, truncate base and with a conical apiculum at the apex (Fig. 2), truncata-campaniformis shape [according to Lakon's (1919) classification], forcefully discharged by the 'conidiophore cannon' mechanism characteristic of the genus Entomophthora sensu stricto, surrounded after landing by a pellicle of protoplasmic residues. They are three- to fivenucleate, the nuclei staining well with acetocarmine and showing characteristic entomophthoraceous condensed chromatin (Humber, 1981). Secondary conidia are similar to but smaller than primary ones, usually lacking the apical apiculum. They are forcibly discharged by the 'rounding-off' or 'papillar eversion' mechanism which prevails in the Entomophthorales (Ben-Ze'ev and Kenneth, 1982) and are therefore not surrounded by protoplasm after landing (Fig.3). Dimensions of primary conidia and their distribution patterns are presented in Table 1. Primary conidiophores are long, unbranched hyphae, each growing as an extension of a hyphal body. After the conidiophore grows out through the host cuticle, the cytoplasm gathers at its tip, becoming cut from the rest of the conidiophore by several empty compartments divided by septa. Prior to conidium production the conidiophore apex becomes clavate and the nuclei, previously arranged in a linear pat-

Table 1. Entomophthora israelensis: distribution of conidial dimensions

PRIMARY CONIDIA

LENGTH µm	no.	WIDTH µm	no.	L/W RATIO l/w	no.
15.0	5	11.0	2	1.1 - 1.15	1
15.8	10	11.8	7	1.16- 1.2	9
16.2	2	12.2	1	1.21- 1.25	10
16.6	13	12.6	18	1.26- 1.3	9
17.4	14	13.0	1	1.31- 1.35	11
18.2	3	13.4	10	1.36- 1.4	6
19.0	1	14.2	8	1.41- 1.45	1
19.8	2	15.0	1	1.46- 1.5	2
		15.8	2	1.56	1
	50		50		50

	(µm)	(µm)	
$\bar{x}$	=16.75	13.05	1.28
s	= 1.1	1.04	0.09
most freq.	=16.6, 17.4	12.6-13.4	
median	=16.6	12.6	

SECONDARY CONIDIA
(undetached from empty primary ones, n = 35)

µm	no.	µm	no.	l/w	no.
10.3	1	9.5	3	1.0 - 1.05	1
11.3	5	10.3	3	1.06- 1.1	7
12.6	14	10.6	14	1.11- 1.15	15
13.4	13	11.3	15	1.16- 1.2	2
14.2	2			1.21- 1.25	10
	35		35		35

$\bar{x}$ =	12.8 µm	11.2 µm	1.15
s =	0.77 µm	0.67 µm	0.06

(mature, detached, without surrounding cytoplasm, n= 15)

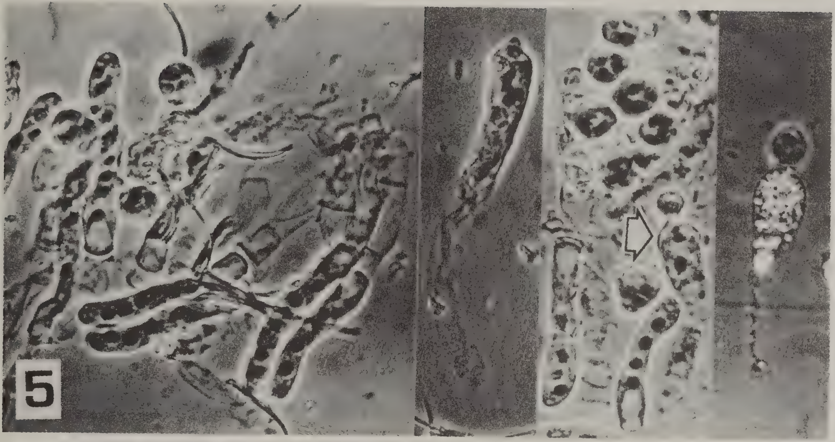
	L (µm)	W (µm)	L/W
min. =	12.6	11.0	1.12
max. =	15.0	12.6	1.27
$\bar{x}$ =	14.2	11.6	1.22
s =	0.82	0.47	0.05

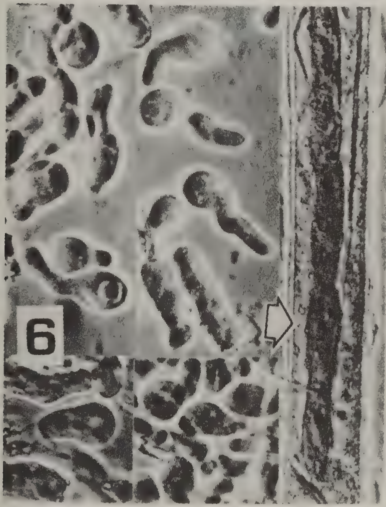
tern, become crowded in the extended tip. The mature conidiophore is an empty, unbranched, septate hypha with a single, clavate conidiogenous cell at its tip. Most of the cytoplasm and nuclei pass from the conidiogenous cell into the conidium. After the latter is separated from its mother cell by the papillar septum, the conidiogenous cell contains mainly clear liquid vacuoles (probably water), some cytoplasm, and occasionally one nucleus (Figs.4-5).

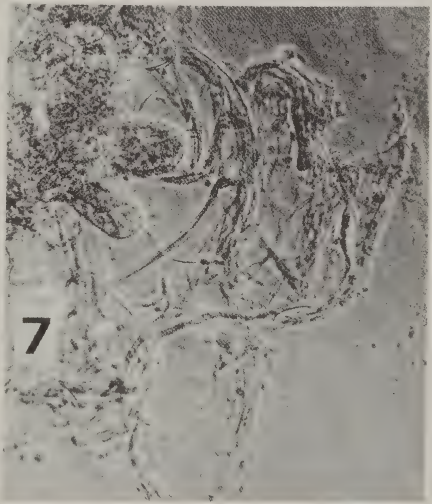
The average nuclear number in conidiophores is higher than that of primary conidia, rare ones having up to 7-8 nuclei. Nuclear numbers, sizes and distributions are given in Table 2. It is worth mentioning that measuring nuclei was much more difficult than measuring conidia, the estimated measuring error being up to 17% of the measured nuclear diameter. In order to overcome this difficulty, nuclei were measured again from photographs carefully enlarged 1000 times, based on measured conidia. Nuclei measured from such photographs were indeed larger than in direct measurements and the measuring error was substantially smaller (1 stage micrometer division = 1.58 µm; 1 photograph division = 1 mm = 1 µm; an average nucleus measures 1.5 - 3 stage micrometer divisions vs. 3 - 5 mm in the photograph).

Hyphal bodies are usually pyriform or ovoid, sometimes short cylinders with rounded ends, with nuclear numbers matching those of conidia and conidiophores, with nuclei that stain less well. They were found throughout the insect body; those viewed inside the legs were long filaments, constricted at rather regular intervals, non-septate, with one nucleus in each swelling between two adjacent constrictions (Fig.6). Rhizoids are long, simple hyphae, apparently unbranched or only poorly branched, with undifferentiated ends, with linearly arranged nuclei in the tip cell, the rest being septate into empty compartments (Fig. 7). They emerge from the mouth area and around the genitalia. Pseudocystidia were absent in all of our samples. Resting spores were not found. All sampled insects sent for identification were found to belong to one, yet unidentified, species of the Supertribe Cecidomyiidi (Diptera). Habitat: on grapefruit and orange leaves, Bet-Oved, Israel, September-October 1983. Type: microscope slide annotated Entomophthora israelensis Ben-Ze'ev & Zelig was deposited at the Farlow Herbarium, together with several paratype slides.

E. israelensis was successfully isolated on a piece of coagulated egg yolk placed on Emerson's YpSs medium (Difco) and subsequently grew on the latter medium. However,







Figs. 5-7: *Entomophthora israelensis* sp.nov. on cecidomyiid midges. 5. Conidiophores arranged in order of increasing maturity from left to right: extreme left – immature ones showing empty compartments below the conidiogenous cells; middle – mature conidiophore with incipient conidial bud at the apex and 4 nuclei clustered below the apex; arrow – mature conidiophore with young (as yet anucleate) conidium; extreme right – trinucleate conidium complete with papillar septum, on anucleate conidiophore (acetocarmine, X 500). 6. Hyphal bodies, nuclei visible in those at the lower right corner; right – long hyphal body in leg, arrow pointing to one of its nuclei (acetocarmine, X 500). 7. Monohyphal rhizoids growing out from the tip of the abdomen of dead midge (acetocarmine, X 250).

Table 2. *Entomophthora israelensis*: distribution of nuclear numbers and size in conidia and conidiophores

NUCLEAR NUMBERS IN PRIMARY CONIDIA no. of nuclei	 no. of conidia
3	27
4	44
5	6
sub-total	77
2-3	2
3-4	8
4-5	3
	13
TOTAL	90

NUCLEAR NUMBERS IN CONIDIOPHORES no. of nuclei	 no. of c-phores
3	5
4	38
5	25
6	3
4-5	1
TOTAL	72

A few occasional ones were observed (outside this counting) to have up to 7 - 8 nuclei.

CONIDIAL NUCLEAR DIMENSIONS

MEASURED IN MICROMETER DIVISIONS (1 div.= 1.58μm)	no.	MEASURED FROM X 1000 PHOTOGRAPHS (1mm = 1μm)	no.
1.5 = 2.4	13	2.8 - 3.0	3
2.0 = 3.2	75	3.8 - 4.0	18
2.5 = 4.0	49	4.4 - 4.5	13
3.0 = 4.7	4	5.0	2
TOTAL	141		36

attempts to isolate it directly on YpSs failed. Subculturing has been carried out since its isolation on Sabouraud's dextrose agar supplemented with 1% yeast extract and 1% Vogel's modified stock solution of salts (Ben-Ze'ev, 1980), and on egg yolk medium. The fungus gradually lost its ability to sporulate on both media.

DISCUSSION

Entomophthora israelensis has all the characters which define, at the generic level, the genus *Entomophthora* (Fres.) sensu stricto Batko (1964), sensu stricto emend. Remaudière & Keller (1980), as accepted in the latest classifications of Entomophthorales (Ben-Ze'ev and Kenneth, 1982, p.448).

At the specific level, the six published species of this genus are distinguished by conidial size, possession or lack of rhizoids, host-specificity, and the ability to sporulate before or after killing the host (MacLeod et al., 1976). Entomophthora erupta (Dustan) Hall, E. weberi Lakon ex Samson, and E. thripidum Samson et al. invade only the abdomens of their hosts, sporulating while the hosts are still alive and moving. All three species lack rhizoids. The other three species invade their hosts completely and sporulate after killing them: E. culicis and E. muscae (Cohn) Fresenius produce monohyphal rhizoids (Balazy, 1984), while E. planchoniana Cornu produces a pseudorhizomorph-like structure (P.L.S.)(Ben-Ze'ev and Kenneth, 1982, pp. 407-8).

Ben-Ze'ev and Ewen (1982) and Keller* have commented on the possibility and advantages of using the number and size of conidial nuclei as additional specific level criteria in plurinucleate genera such as Entomophthora sensu stricto, specifically in order to distinguish between E. erupta and a superficially similar species described by Keller (1981) (to be published under the name Entomophthora helvetica: Ben-Ze'ev, Keller, and Ewen, in preparation), and between different strains of the 'E. muscae complex' (Keller*). The criteria of nuclear number and size in conidia, conidiophores, and hyphal bodies have been accepted and will be utilized in papers describing the unpublished species of Entomophthora mentioned here. Table 3 lists most of the important characters which are useful in distinguishing between published and unpublished species of Entomophthora (resting spore related characters have been omitted due to the relatively low taxonomic importance attributed to them at present).

Entomophthora israelensis and "E. brevinucleata" (a new species; S. Keller, in preparation, pers. commun.) share many characters such as conidial dimensions and general shape, monohyphal rhizoids, sporulation after host's death, colonization of host's whole body, and both attack cecidomyiid midges (Table 3). Indeed, at present only the criteria of nuclear numbers and size allow a clear distinction between these two species; biochemical differences are also probable, but have not been investigated yet. The same applies for some strains in the 'E. muscae complex' of which

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* S. Keller, informal lecture given at the XVI-th S.I.P. Annual Meeting, Cornell University, Ithaca, N.Y., August 1983.

Table 3. List of some specific level characters of *Entomophthora* species

ENTOMOPHTHORA species	CONIDIAL SIZE (μm)	CONIDIAL NUCLEAR NO.	CONIDIAL NUCLEAR SIZE (μm)	RHIZOIDS	SPORULATION RELATIVE TO HOST DEATH	CONIDIOPHORE NUCLEAR NO.	COLONIZATION OF HOST BODY	HOSTS
"muscae complex" [1]	av.25.1 x 19.8	4 - 6	4.0 - 5.5	mono(hyphal)	a(fter)	2 - 7	w(hole)	DIPTERA: various flies
	similar	8 - 13 (14)	2.4 - 3.2		a	8 - 16	w	
culicis [2]	9.16 x 8.15	(1) 2 (3)	?	mono	a	?	w	DIPTERA: Culicidae, Chironomidae
planchoniana [1,2]	11-23 x 10-20 av.18-19 x 13-15	4 - 6 (7)	?	P.L.S.*	a	4 - 8	w	HOMOPTERA: aphids, leaf-hoppers
erupta [1,2,3]	17-23 x 15-18	(1,2)3,4(5-9)	(2.6)3.6,4.1(4.6)	a(bsent)	b(efore)	3 - 6(-?)	only a(bdomen)	HETEROPTERA: Miridae
weberi [2,4]	12-18 x 11-16 av.16 x 13	ca. 6	?	a	b	ca. 6	a	NEUROPTERA: Raphidiidae
thripidum [4]	10-15 x 8- 12	2 - 4	?	a	b	?(2 - 4)	a	THYSANOPTERA: Thripidae
israelensis [5]	15-19.8 x 11-15.8 av.16.7 x 13	3 - 5	3.8 - 4.5(5.0)	mono	a	3 - 6(8)	w	DIPTERA: Cecidomyiidi
"helvetica" [6]	16-24 x 12-19 av.20 x 16.1	(6)8-13(18)	2.0	a	a	usually 8 - 15	w	HETEROPTERA: Miridae
"brevinucleata" [7]	11.2 - 18.9 x 8.7 - 15.8	(3)4-10(13)	2.7 - 3.7	mono	a	(3)5 - 11(17)	w	DIPTERA: Cecidomyiidae

[1] Ben-Ze'ev, unpublished observations. N.Wilding (pers. commun.) and S.Keller (in preparation, pers. commun.) confirm these observations and increase the range with strains differing from the above-listed in hosts, conidial size, nuclear number and size. [2] MacLeod *et al*.(1976). [3] Dustan (1924). [4] Samson *et al*.(1979). [5] Present paper. [6] Ben-Ze'ev, Keller, and Ewen (in preparation). [7] Keller (in preparation, pers. commun.). Unpublished names (in preparation) appear in quotation marks.

* P.L.S. = pseudorhizomorph - like structure (see text).

only two strains (probably species) have been listed in Table 3, others have been listed by Keller (XVI-th S.I.P. Ann. Meeting, 1983, and in preparation).

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MYCOTAXON

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CAUDOSPORA TALEOLA: ANAMORPH AND SYSTEMATIC POSITION

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ABSTRACT

The *Phomopsis*-like anamorph of *Caudospora taleola* is described from culture. The ascospores of *C. taleola* and *Diaporthe leiphaemia* var. *raveneliana* are shown to be verrucose, whereas those of *Hercospora tiliae* --- the type species of the genus to which *C. taleola* is often assigned --- are smooth. Moreover, the anamorph of *H. tiliae* is reported to be *Rabenhorstia tiliae*, a coelomycete with holoblastic conidiogenesis. It is concluded that *Caudospora* Starb. should not be considered synonymous with *Hercospora* Fr. Possible relationships among *C. taleola* and certain species of *Diaporthe* and related genera are discussed, but taxonomic conclusions and rearrangements seem premature.

Caudospora taleola (Fr.) Starb. [≡ *Hercospora taleola* (Fr.) Müller] is a widely distributed inhabitant of *Quercus* spp. It has been studied or described by a number of workers (see later). Synonyms have been listed by Müller and von Arx (1962) under *H. taleola* and by Wehmeyer (1933) under *Diaporthe taleola* (Fr.) Sacc. Wehmeyer (1933) also summarized literature dealing with the anamorph.

I have recently studied fresh teleomorphic material of *C. taleola* from natural substrates and have characterized the anamorph from cultures. Because my findings are, in part, new and raise taxonomic questions the fungus is redescribed here.

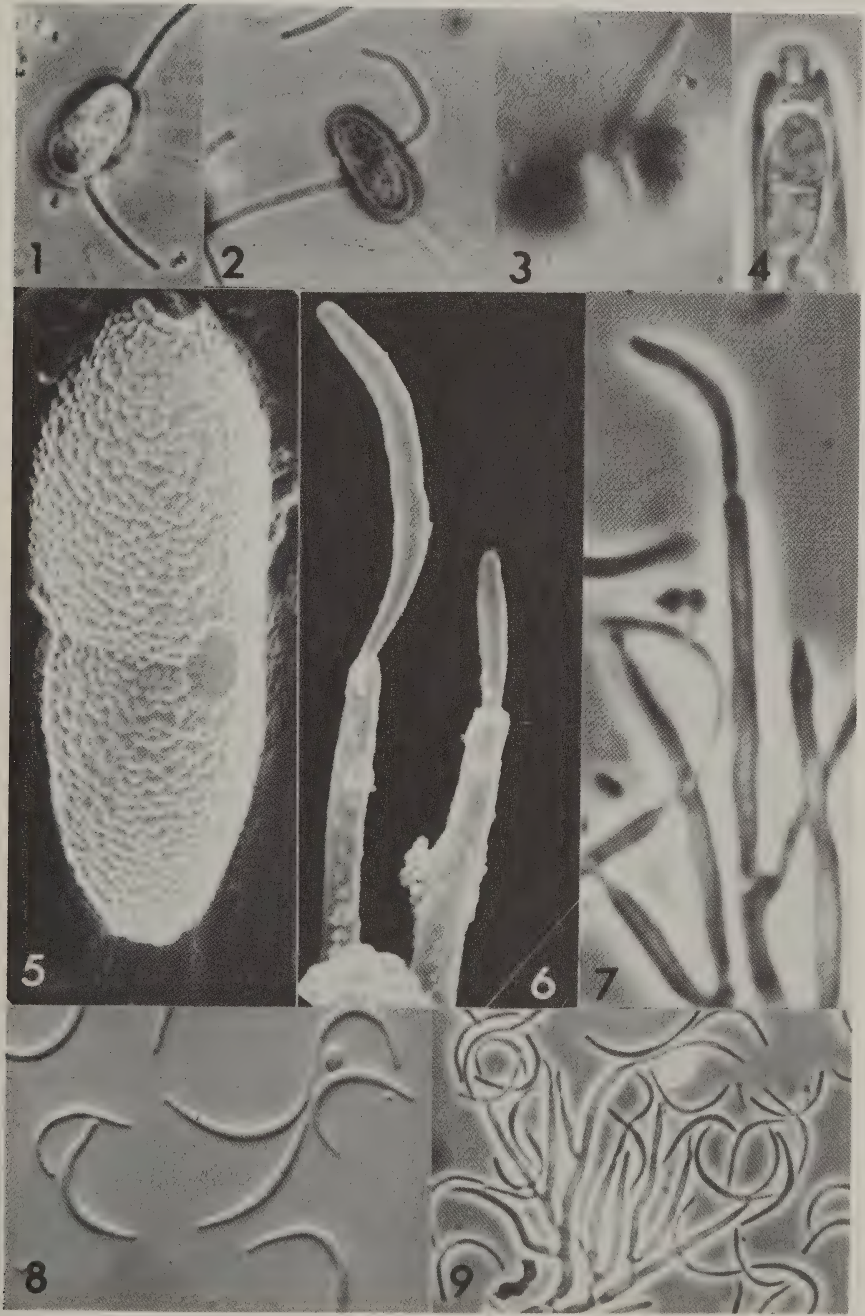
Caudospora taleola (Fr.) Starb. Figs. 1-9; 14.

Stromata evident on host bark as erumpent whitish discs bearing blackish ostioles which range from hemispherical to low and inconspicuous. Perithecia blackish, 0.3-0.5(-0.7) mm diam, usually 6 or more embedded in a soft, tan to yellowish entostroma which is bounded by a conspicuous zone line. Necks of 2-3 or more perithecia united and collectively discharging through a single ostiole. Asci 8-spored, bearing ascospores in a uniseriate or partially biseriate arrangement, cylindrical to somewhat clavate, with a conspicuous apical ring (Fig. 4), with short or obsolete stipe, rounded at the base, eventually becoming detached from the hymenium, (110-)120-160(-200) X 12-15 µm. Ascospores two-celled, hyaline, more or less ellipsoidal, somewhat constricted at the septum, ornamented with closely spaced verrucae which are detectable by light microscopy (Fig. 3) and clearly revealed with scanning electron microscopy (Fig. 5), (18-)20-26(-28) X 9-11 µm, with an appendage up to 30 X 1-1.5 µm at each end and 3 similar median appendages originating near the septum (Figs. 1, 2).

Colonies initiated from multiple ascospores on 2% oatmeal agar (Difco) incubated in natural daylight/darkness at about 22°C covering 9 cm diam Petri dish in 3 wk, of sparse white appressed mycelium bearing concentric zones of stromata 1-3 mm diam X 1-2 mm high, the zones separated by 5-10 mm (Fig. 14). Stromata at first gray, becoming mottled with blackened areas and producing droplets of amber fluid. Reverse uncolored.

Figs. 1-9. Caudospora taleola. 1. Ascospore showing one terminal and one lateral appendage, X 800. 2. Ascospore showing two (of three) lateral appendages, X 800. 3. Ascospore (out of focus) showing surface ornamentation, X 1000. 4. Portion of ascus showing ascus tip ring and terminal ascospore, X 1000. 5. Ascospore showing verrucose surface. Note appendage scars on septum indentation and on upper end, X 4000. 6. Two phialides bearing conidia, the conidium on the right not completely formed, X 5000. 7. Phialides, one of which bears a conidium, X 2800. 8. Conidia, X 1000. 9. Portion of conidiogenous hymenium showing origin and arrangement of phialides, X 900.

Figs. 1, 2, 4, 7, 9 by darkfield phase microscopy. Figs. 3, 8 by differential interference contrast microscopy. Figs. 5, 6 by scanning electron microscopy. Figs. 1, 2, 4 from Petrak, 1936. Other figs. from Rogers, 1983. See text for complete citations of collections.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Conidiomata pycnidial, produced in some stromata after 8 wk, becoming conspicuous by the release of milky drops of conidia. Conidiomata up to 1 mm diam, shallow, regular to convoluted within, releasing conidia through pores. *Conidiogenous cells* long, tapering phialides, produced dichotomously or irregularly, often more or less whorled, originating from underlying hyphae (Figs. 6, 7, 9). Phialides often with minute nonflaring collarettes and internal periclinal thickenings. *Conidia* unicellular, hyaline, smooth, elongated, from more or less straight or sigmoidal to falcate or C-shaped, thickest at the middle and tapering to the apices (Figs. 6, 7, 8, 9), (5-)10-17 X 1-1.5 μm. Conidia not germinating.

The anamorph of *Caudospora taleola* as described here from cultures is *Phomopsis*-like in producing β-conidia in pycnidia; α-conidia were not seen. I have not seen anamorphic *C. taleola* from natural substrates. There are, however, numerous reports of anamorphic *C. taleola* [usually as *Aglaospora taleola* (Fr.) Tul. or *Diaporthe*] from natural substrates. Tubeuf and Smith (1897) illustrated and discussed *C. taleola*, their illustrations and, apparently, their data taken from an earlier paper by Robert Hartig. The sickle-shaped conidia and shallow conidiomata depicted by Tubeuf and Smith (1897) are in essential agreement with my observations. Other workers have reported conidia that are substantially broader and/or longer than those reported herein. Tulasne and Tulasne (1863) observed conidia of two types --- elongated conidia 20-30 X 4 μm and globose conidia 3.5 μm diam. Fuckel (1871-72) reported stylospores 24 X 4-5 μm and "leucoconidia" 16 X 8 μm. Saccardo (1884) in volume 3, page 726 of Sylloge Fungorum initially described the anamorph as having a suborbicular plane acervulus bearing conidia 16 X 8 μm; he named this state *Myxosporium taleola* Sacc. Later in the same volume (page 745) he gave the conidia as 20-30 X 4 μm, now naming this state *Libertella taleola* Sacc. Höhnel (1915) re-examined some of Fuckel's material and was impressed by the hyaline, viscous "slime mass" of conidia borne in shallow subperidermal conidiomata which seemed to lack conidiophores. He reported sickle-shaped to club-shaped conidia 10-22 X 5 μm. Höhnel (1915) created the form-genus *Endogloea* Höhnel, with the type species *E. taleola* (Sacc.) Höhnel, to accommodate it. Sutton (1977) discussed *Endogloea* and, based upon Petrak's contention that it is a melanconioid *Phomopsis*, was inclined to consider it a later synonym of *Phomopsis* (Sacc.)

Sacc. Sutton formally listed it as a synonym in a later work (1980).

There are various possible reasons why descriptions of anamorphic Caudospora taleola from natural substrates are not in total agreement with my description from cultures. First, some workers might have mistakenly described anamorphic states of fungi other than of C. taleola. Second, some descriptions might include elements of several different anamorphic fungi. Third, it is possible that European C. taleola differs from the North American fungus from which I made isolations. The European material that I examined, however, seemed morphologically very similar to North American material. As far as I know, only Gilman et al. (1959) have reported conidial C. taleola from natural substrates from North America, describing the conidia as cylindric, curved, one-celled, hyaline, 20-30 X 4-5 μm. Fourth, it is quite possible that dimensions and shapes of conidia from natural substrates differ from those produced in culture. I was unable to test this possibility. Moreover, the effects of various culture media on conidial morphology could not be evaluated because, although a variety of media supported growth of the fungus, it fruited only on oatmeal agar. Finally, it is possible that C. taleola produces a second conidial type in nature which is morphologically distinct from the one described herein and which is not produced under culture conditions thus far employed.

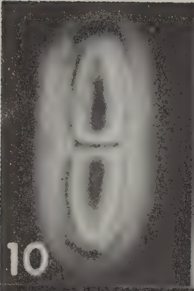
Ascospores of Caudospora taleola have been described previously as smooth or, in any case, ornamentation has not been mentioned. As shown earlier herein, the ascospores are closely verrucose. This ornamentation can be detected by light microscopy, especially after the spores have been mounted in a dilute solution of acid fuchsin in water or lactophenol. It is fully revealed by scanning electron microscopy. Ascospores with verrucae appear to be uncommon among diaporthaceous fungi, as do those with both terminal and lateral appendages. The combination of verrucose wall with lateral and terminal appendages appears to be unique among diaporthaceous fungi.

What is the taxonomic status and position of Caudospora taleola? Reference to Wehmeyer (1933) shows that it has been placed in Valsa and Melanconis, in addition to the genera cited herein. Muller considered the fungus to be a species of Hercospora Fr. (Müller and Arx, 1962) and most modern students of the group have at least tentatively accepted this disposition (e.g., Barr, 1978; Kobayashi, 1970). Characters emphasized include the discrete stromata demarcated by blackened tissue (zone line), fused ostiolar canals, and more or less cylindrical asci (see Barr, 1978). Examination of ascospores of *H. tiliae* (Pers. : Fr.) Fr., the type species of *Hercospora*, shows them to be smooth and devoid of appendages (Figs. 12, 15). Moreover, the anamorph of *H. tiliae* is assumed to be *Rabenhorstia tilliae* (Fr.) Fr. (Fig. 16), depicted by Sutton (1980) as producing conidia holoblastically. Thus, in my opinion *Caudospora taleola* should not be considered a *Hercospora*; *Caudospora* Starb. is not to be considered a synonym of *Hercospora*.

Wehmeyer (1933) considered the fungus under discussion to be a *Diaporthe* and, moreover, believed it to be European. He stated that North American material examined by him was *D. leiphaemia* (Fr.) Sacc. or *D. leiphaemia* var. *raveneliana* (Thüm. & Rehm) Wehm., the latter taxon accepted by Kobayashi (1970) as *Cryptodiaporthe raveneliana* (Thüm. & Rehm) Kobayashi and by Barr (1978) as *Amphiporthe raveneliana* (Thüm. & Rehm) Barr. Both Kobayashi (1970) and Barr (1978) considered typical *D. leiphaemia* to be a European taxon and did not treat it formally. In any case, Gilman et al. (1959) showed that *C. taleola* (as *Diaporthe*) is indeed present in North America and numerous extant herbarium specimens indicate that it is not uncommon.

Figs. 10-16. *Diaporthe leiphaemia* var. *raveneliana*, *Hercospora tiliae*, *Caudospora taleola*, and *Rabenhorstia tiliae* state of *Hercospora tiliae*. Figs. 10-11. *Diaporthe leiphaemia* var. *raveneliana*. 10. Ascospore, X 1500. 11. Ascus apex. Note apical ring, X 1500. Fig. 12. *Hercospora tiliae*. Ascospore, X 1700. Fig. 13. *Diaporthe leiphaemia* var. *raveneliana*. Ascospore. Note surface ornamentation, X 6000. Fig. 14. *Caudospora taleola*. Culture. Note concentric zones of stromata, X 0.9. Fig. 15. *Hercospora tiliae*. Ascospore, X 3000. Fig. 16. *Rabenhorstia tiliae*. Conidia, X 1400.

Figs. 10-12 by darkfield phase microscopy. Figs. 13, 15, 16 by scanning electron microscopy. Fig. 14 by macrophotography. Figs. 10, 11, 13 from Cain, 1963. Figs. 12, 15 from Barr, 5846b. Fig. 14 from Rogers, 1983. Fig. 16 from Barr, 4066. See text for complete citations of collections.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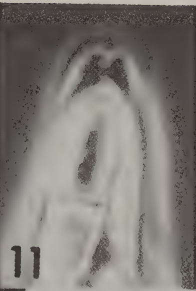
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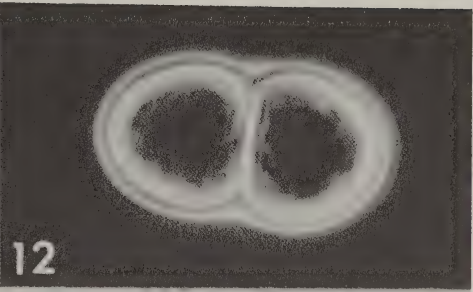
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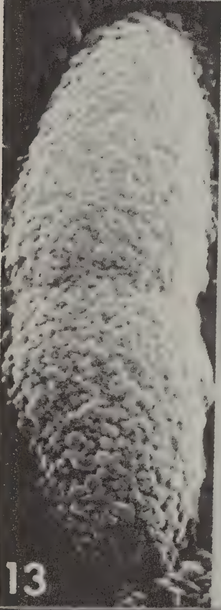
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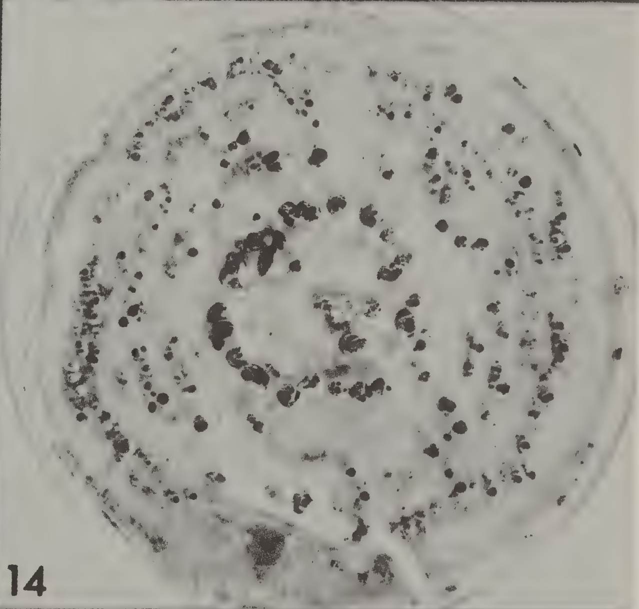
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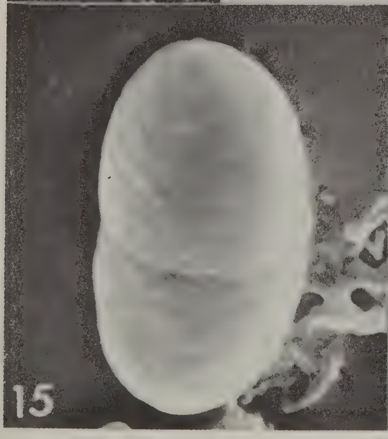
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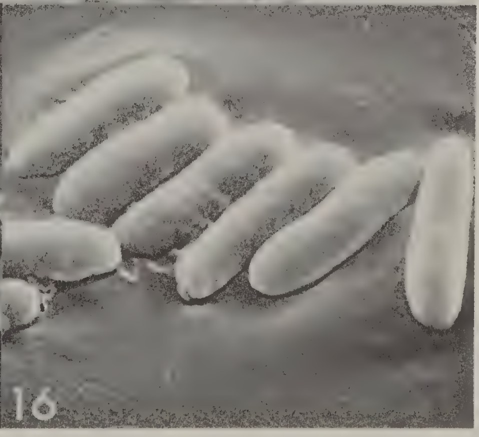
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What is the relationship between *C. taleola* and *D. leiphaemia* var. *raveneliana*? Ascospores and the ascus tip of *D. leiphaemia* var. *raveneliana* are shown in Figs. 10 and 11. Scanning electron microscopy revealed the ascospore surface to be verrucose in a pattern suggestive of that of *C. taleola* (Fig. 13). In several cases very short protuberances were seen by light microscopy, but no appendages or appendage scars were noted by scanning electron microscopy of a relatively few ascospores. Two types of conidia were noted by Wehmeyer (1933) and by Kobayashi (1970) for *D. leiphaemia* var. *raveneliana*, the former investigator observing both types in culture and the latter finding only one type in culture. The so-called allantoid conidium of Kobayashi (1970), which corresponds to the β-conidium of Wehmeyer (1933), has features and dimensions reminiscent of conidial *C. taleola* as reported herein. Wehmeyer (1933) considered conidial *D. leiphaemia* var. *raveneliana* to be intermediate between *Phomopsis* and *Fusicoccum*; Barr (1978) indicated that it is *Fusicoccum*-like. According to Sutton (1980) *Fusicoccum* Corda produces conidia holoblastically. The anamorph of *D. leiphaemia* var. *raveneliana* should be reinvestigated with emphasis on mode of conidiogenesis.

There apparently is a relationship between the *Quercus*-inhabiting species, *Caudospora taleola* and *Diaporthe leiphaemia* var. *raveneliana*. There presently are, however, too many uncertainties and unsolved problems to propose taxonomic rearrangements.

Collections of *Caudospora taleola* examined: EUROPE: Petrak, F., IV.1936, ?Austria (NY); Krieger, W., "Fungi saxonici," no. 966, V-VI.1894, East Germany, on decaying oak twigs (NY); Kochman, J., "Mycotheca polonica," no. 345, fasc. 14, 18.VII.1963, Gdynia-Orlowo, Poland, on *Quercus* sp. (NY); Petrak, F., "Mycotheca carpatica," no. 208, VIII.1923, ?Romania, on *Quercus robur* (NY). NORTH AMERICA: Dearness, J. 1.VI.1893, London, Ontario, Canada, on *Quercus* (NY); Holway, E. W. D., 9.VI.1886, Decorah, Iowa, USA, on *Quercus* (NY) (as *Valsa taleola*); Rogers, J. D., 15.VIII.1983, North Bend Park, Ritchie Co., West Virginia, USA, on *Quercus* sp. (J. D. Rogers herb.) (COLLECTION FROM WHICH CULTURES WERE MADE).

Collections of *Diaporthe leiphaemia* examined: EUROPE: Hughes, S. J., 12.IX.1947, Stoke Woods, Devon, England, on *Quercus* sp. (NY ex IMI 19024); Rehm, "Ascomyceten," no. 476, ?Germany, on oak twigs (NY); Rabenhorst, "Fungi europaei," IX.1876, Bosco Montello, Treviso, Italy, on *Quercus* (NY); Kochman, J., "Mycotheca polonica," no. 361, fasc. 15, 13.X.1962, District Pruszków, Poland, on *Quercus* sp. (NY).

Collections of *Diaporthe leiphaemia* var. *raveneliana* examined: NORTH AMERICA: Cain, R. F., 20.V.1963, Walsingham, Norfolk Co., Ontario, Canada, on *Quercus* (NY ex TRTC 40071); Wehmeyer, L. E., 10.XII.1921, Ann Arbor, Michigan, on *Quercus alba* (NY); Ravenel, "Fungi caroliniani exsiccati," no. 69, fasc. 3, South Carolina, on *Quercus alba* (NY) (as *Valsa taleola* Fr.).

Collections of *Hercospora tiliae* examined: EUROPE: Kochman, J., "Mycotheca polonica," no. 376, fasc. 16, 22.V.1961, Warszawa-Mokotow, Poland, on *Tilia* (NY); NORTH AMERICA: Barr, M. E., no. 5846b, 27.VIII.1971, near Carrabassett, Franklin Co., Maine, USA, on *Tilia* branches (MASS); Barr, M. E., no. 6691, 3.II.1980, Baptist Hill, Conway, Massachusetts, USA, on *Tilia americana* (MASS); Barr, M. E., no. 4066, 12.VIII.1963, Rocky Branch Trail, Jericho, White Mountains National Forest, New Hampshire, USA, on *Tilia* (MASS).

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MYCOTAXON

Vol. XXI, p. 485 October-December 1984

HOLOTYPE SPECIMEN OF PYTHIUM NUNN

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The holotype specimen number for *Pythium nunn* Lifshitz et al. (1984) is CUP 61143.

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MYCOTAXON

Vol. XXI, pp. 487-490 October-December 1984

A NORTH AMERICAN RECORD OF **MYRIOGONIUM ODONTIAE**

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In December 1983, we collected **Dacryobolus sudans** (Alb. & Schw.:Fr.) Fr. (Corticiaceae) on dead branches of Douglas-fir (**Pseudotsuga menziesii** [Mirb.] Franco) at Finley Game Refuge, near Corvallis, Oregon. Initial examination of the hymenium revealed structures which appeared to be broadly clavate cystidia. On closer examination these were found to be the naked eight-spored asci of **Myriogonium odontiae** Cain.

Cain(1948) first described **Myriogonium odontiae** from a single European collection of **Odontia sudans** (Alb. & Schw. : Fr.) Bres. (≡ **Dacryobolus sudans**). We discovered **M. odontiae** during a routine examination of **D. sudans:** as Cain reported, the presence of **M. odontiae** on its host is not evident even when examined at 50x with a dissecting microscope. Approximately 1 cm^2 of the 8 cm^2 hymenium of our collection of **D. sudans** was colonized by **M. odontiae.** One additional collection of **D. sudans** bearing **M. odontiae** was made in February 1984 at the same location. Our collections of **M. odontiae** represent the first report of this Ascomycete since Cain's original description and extend its range to North America. We are informed that neither BPI, CUP, DAOM, FH, MICH, OSC, nor WASH have North American material of **M. odontiae**; in fact, the type at TRTC is the only collection known to us. We have not examined herbarium material of **D. sudans** for **M. odontiae** because detecting the presence of **Myriogonium** on its host requires random destruction of portions of **D. sudans** specimens.

Myriogonium odontiae lacks an ascocarp. The asci appear at different stages of development in small clusters scattered in the basidiomycete hymenium (Fig. 1A). The ascomycete does not appear to harm the development of the basidiomycete, as fully mature basidia and basidiospores were observed on the **Dacryobolus** sporocarp (Fig. 1B). The asci of **M. odontiae** are broadly clavate

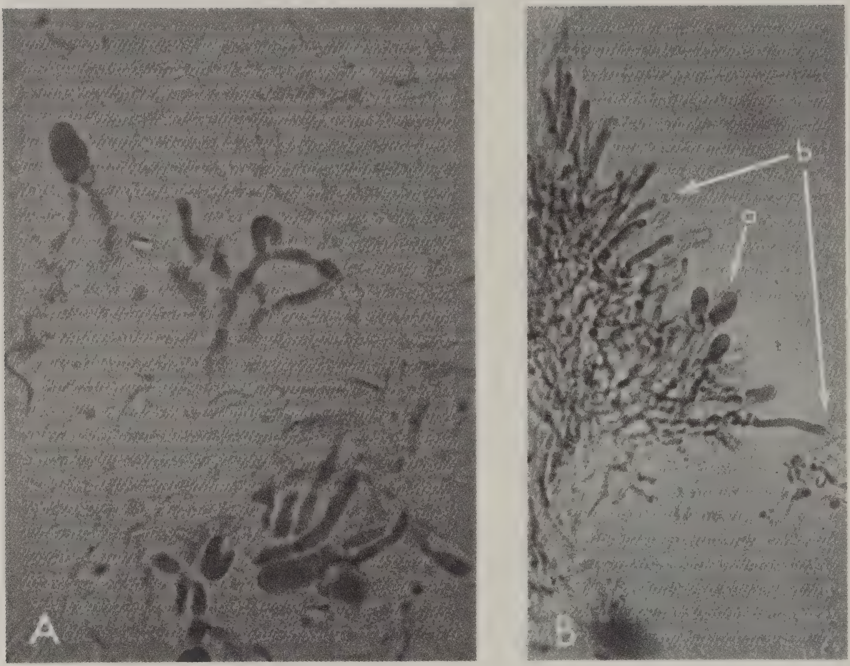

FIGURE 1. A. Developing asci of **M. odontiae**, phloxine squash mount, x1300; B. Asci of **M. odontiae** in a section through the hymenium of **Dacryobolus sudans**, mounted in phloxine, x640; arrows denote asci (a) and basidia (b).

with a thick, papillate apex; when devoid of ascospores, they are easily mistaken for cystidia of a basidiomycete. As Cain reported, the asci are 18-25 x 5-7 μm, and the ascospores are 5-6 x 1.5 μm.

The salient features of **M. odontiae** were well described by Cain (1948); we add one important observation. He originally reported no reaction of the asci to iodine. Since then, Kohn & Korf (1975) and Nannfeldt (1976) found that pretreatment of asci with hydroxyl reagents is often necessary to obtain a blueing reaction in iodine reagents. We gently heated slides of **M. odontiae** mounted in 3% aqueous KOH, removed the excess KOH with filter paper, and replaced the fluid with Melzer's reagent. Asci so treated were usually diffusely violet-blue at the apex, and occasionally an entire ascus turned blue. We observed no internal pore walls, or any other specialized apical apparati in the asci. Asci which had discharged their spores appeared to have simply ruptured at the apex.

Most asci in squash mounts had not discharged their spores. Asci of **M. odontiae** may be long-lived, requiring high moisture content or some other factor for discharge. We offer this opinion because the sporocarps of the host fungus were on dead branches suspended above the ground, a

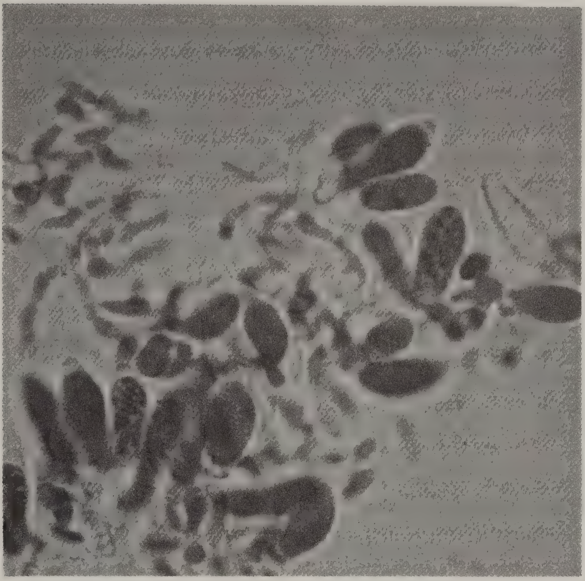

FIGURE 2. Asci and ascospores of **M. odontiae**, squash mount in phloxine, x1500.

dryer habitat than the forest floor. If the asci were alternately wetted and dried, thick-walled asci would resist collapse before ascospore maturation, an especially important trait as the asci are not enclosed by ascocarp tissues. The means of dissemination of **M. odontiae** from host to host remains unclear, as does its host range. We do not know whether **M. odontiae** colonizes other resupinate aphyllophoralean fungi, or if it is restricted to **Dacryobolus sudans.** We do not know if **M. odontiae** colonizes **D. sudans** via aerially dispersed ascospores or some other means. The small sporocarps of **D. sudans** are widely scattered in the area we collected **M. odontiae.**

Therefore, the ability of **M. odontiae** to colonize a dispersed substrate would indicate either a wider host range than we are aware, or a specialized mode of dispersal, such as a mycophagous insect or other animal. We are initiating cultural studies of **M. odontiae** to investigate some of these possibilities.

SPECIMENS EXAMINED

NORTH AMERICA. UNITED STATES OF AMERICA. Oregon. Benton Co. Just west of Finley Wildlife Refuge in second-growth Douglas-fir stand [**Pseudotsuga menziesii** (Mirb.) Franco], on sporocarps of **Dacryobolus sudans** (Alb. & Schw.: Fr.)

Fr., from the undersides of dead Douglas-fir branches still on the tree. Leg. Brad Kropp, s.n., Dec 1983, OSC #41,590; Feb 1983, OSC #41,591.

ACKNOWLEDGEMENTS

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SOUTHERN APPALACHIAN RUSSULAS. II

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SUMMARY

Morphological and/or habitat descriptions, illustrations and taxonomic discussions of eight species of *Russula* occurring in northern hardwood and spruce-fir forests in the Southern Appalachian Mountains of North America are presented. *Russula ochroleucoides*, *R. modesta*, *R. polycystis* and *R. redolens* are redescribed. *Russula betularum* is described from North America for the first time. New information on distributions and habitats of *R. brunneola*, *R. granulata* and *R. peckii* is provided.

INTRODUCTION

This is the second in a series of papers documenting *Russula* species in the Southern Appalachian Mountains of North America (see also Bills and Miller, 1984). This paper focuses on species occurring in the red spruce-Fraser fir, red spruce-northern hardwood and mesic northern hardwood forest types (Whittaker, 1956) of the higher elevations of the unglaciated Appalachian Mountains. All of the species reported here fruit in one of more of these forest types. Some are known only from these forests while others are more widely distributed.

Many North American Russulas remain inadequately described or are without descriptions readily available in the North American literature. As a result, many species have not been recognized over wide geographical areas, if at all. The excellent *Russula* descriptions and keys of Shaffer (1970, 1972, 1975) were the foundation for the acquisition of new data on the habitat and distribution of *R. brunneola* Burlingham, *R. granulata* Peck and *R. peckii* Singer and the report of another member of the subsection *Emeticinae*, *R. betularum* Hora, in eastern North America. In addition, detailed, illustrated descriptions, habitat information, possible mycorrhizal associations and taxonomic discussions of four other *Russula* species are provided.

MATERIALS AND METHODS

Line drawings were made with the aid of a drawing tube. Basidiospores were drawn to the 10 µm standard bar. All other structures were drawn to the 20 µm bar. Stippling indicates refractive contents of cystidia and laticifers. Capitalized color names are from Ridgway (1912) and those numerically designated, eg. 5B5-2, are from

Kornerup and Wanscher (1978). Spore-print and some lamellar colors are from Romagnesi (1967). Macrochemical and microchemical tests were made according to the methods of Romagnesi (1967) and Singer (1975). Basidiospore size and shape are from optical sections in side view and exclude the ornamentation. The letters SV stand for sulfovanillin and GSMNP for the Great Smoky Mountains National Park.

DESCRIPTIONS OF TAXA

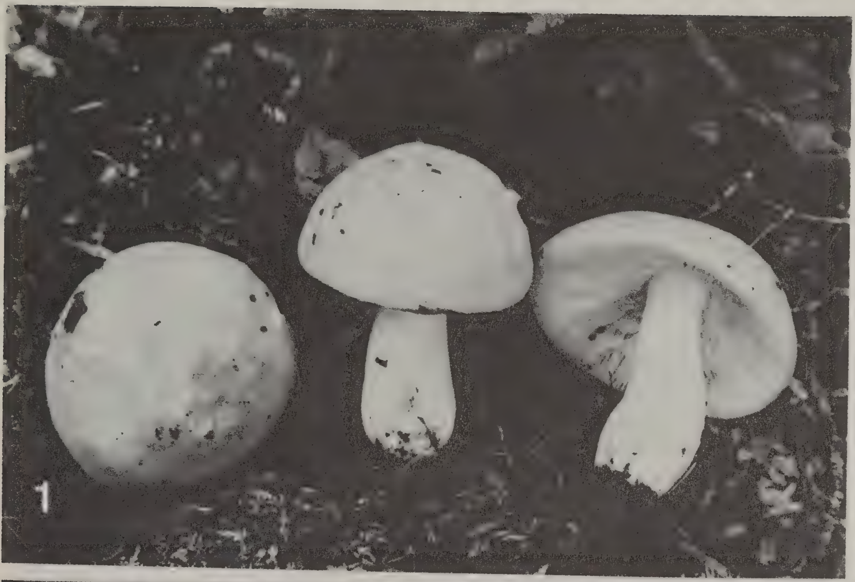
RUSSULA OCHROLEUCOIDES Kauffman, *Mycologia* 9: 165. 1917.
FIGS. 1, 9-13

Russula mariae var. *subflavida* Singer, *Bull. Soc. Mycol. France* 55: 244. 1939.
Russula dura Burlingham, *Mycologia* 16: 19. 1924.
Russula subochroleuca Murrill, *Mycologia* 30: 363. 1938.
Russula levispora Murrill, *Lloydia* 6: 212. 1943.
Russula levisporiformis Murrill, *Lloydia* 8: 266. 1945.
Russula lutescentifolia Murrill, *Lloydia* 8: 267. 1945.

Pileus 4-12 cm broad, hemispherical to convex when young, becoming broadly convex to plane, plano-depressed at maturity; margin obtuse, not striate, obscurely striate or slightly sulcate; cuticle inseparable or slightly separable at margin, often preferentially consumed by gastropods; surface moist to dry, dull, pruinose, velvety, sometimes faintly concentrically rugulose near margin when young, minutely rugulose, sometimes with finely areolate patches, pale to dark yellow, Warm Buff, Maize Yellow, Buff-Yellow, Apricot Yellow, 4A8-4, 4B8-4, 3A4, yellowish orange, Antimony Yellow, Chamois, Light Orange-Yellow, Honey Yellow, Yellow Ocher, Ochraceous-Buff, 5A5-3, 5B7-5, sometimes pinkish orange, 6A4, near margin when young, sometimes brownish orange to brown, Buckthorn Brown, Terra Cotta, 5C7 over the disc, rarely with olive-yellow, 3B4, tones in age; trama hard, rigid to pliant when fresh, brittle in age, up to 4-6 mm thick at midradius, white to pale buff, unchanging when cut; odor indistinct; taste mild to bitter or slightly acrid.

Lamellae adnate to adnexed, close to medium, forked near stipe, occasionally forked at other levels, with a few scattered lamellulae, intervenose, up to 11 mm broad at midradius, rounded to subacute in front, tapered toward stipe, white when young, soon cream to pale yellow, Cream-Buff, (Romagnesi II a-b); edges thick, even to eroded in age, rarely yellow inward up to one-third way from pileus margin, sometimes staining or spotted yellowish brown.

Stipe 3.5-8 cm tall, 1-3.5 cm wide at midpoint, often robust, equal or expanded at apex or tapered at base, sometimes fluted at apex or longitudinally sulcate at the base; surface dry, dull, chalky, glabrous to minutely pruinose, sometimes scurfy at the base, longitudinally rugulose, white or flushed pale to medium yellow from base upward; pruinose layer sometimes collapsing and discoloring yellowish brown upon handling; trama hard, solid when young, spongy in age, white, unchanging.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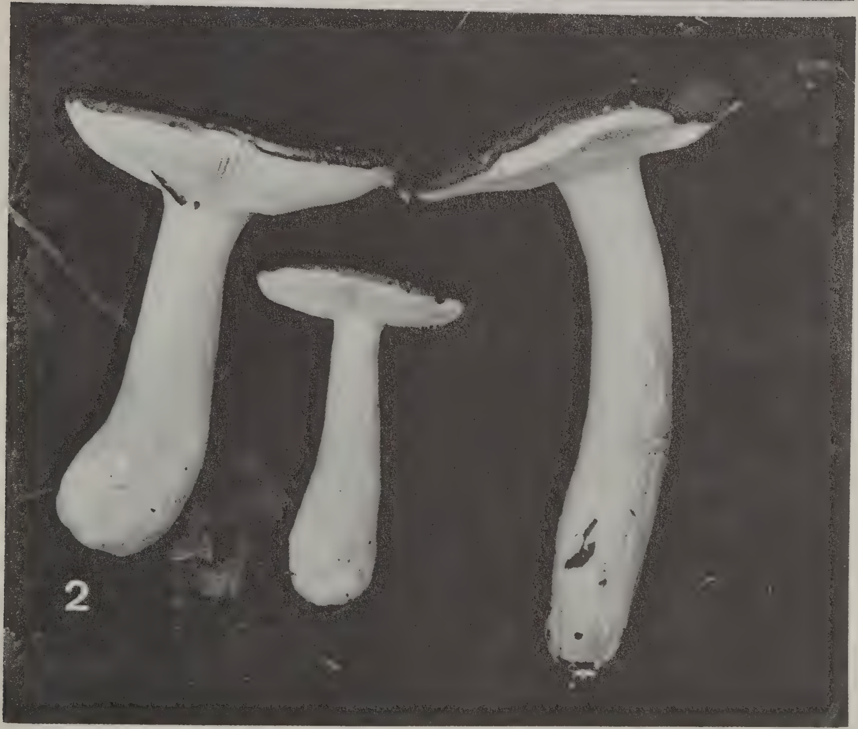
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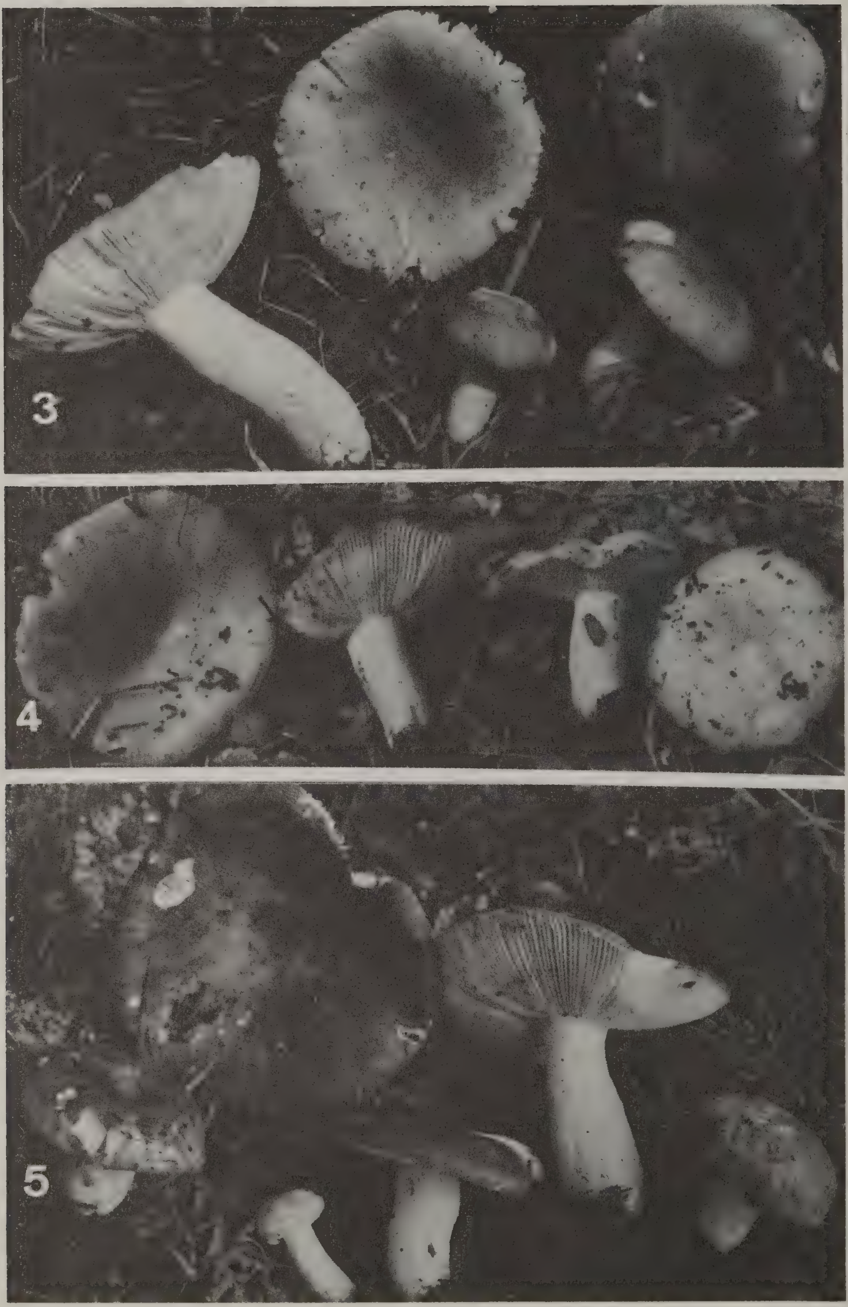
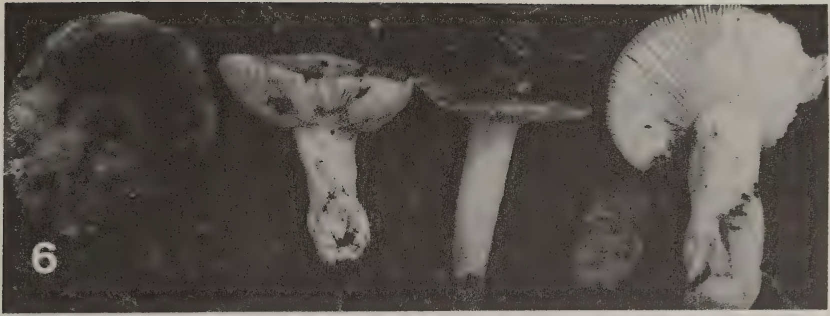
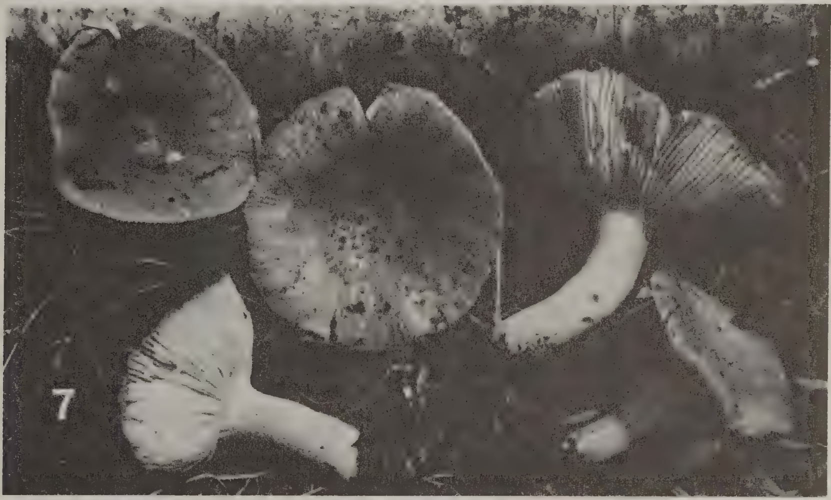
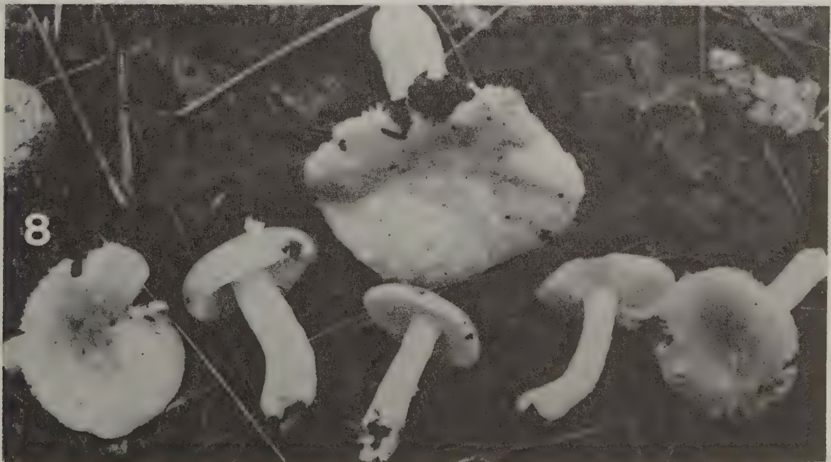
FIGS. 1, 2. *Russula*. 1. *R. ochroleucoides* (GB 820), X1/3. 2. *R. peckii* (GB 513), X1.



FIGS. 3-5. *Russula*. 3. *R. modesta* (GB 441), X1/2. 4. *R. polycystis* (GB 449), X1/2. 5. *R. brunneola* (GB 621), X3/5.







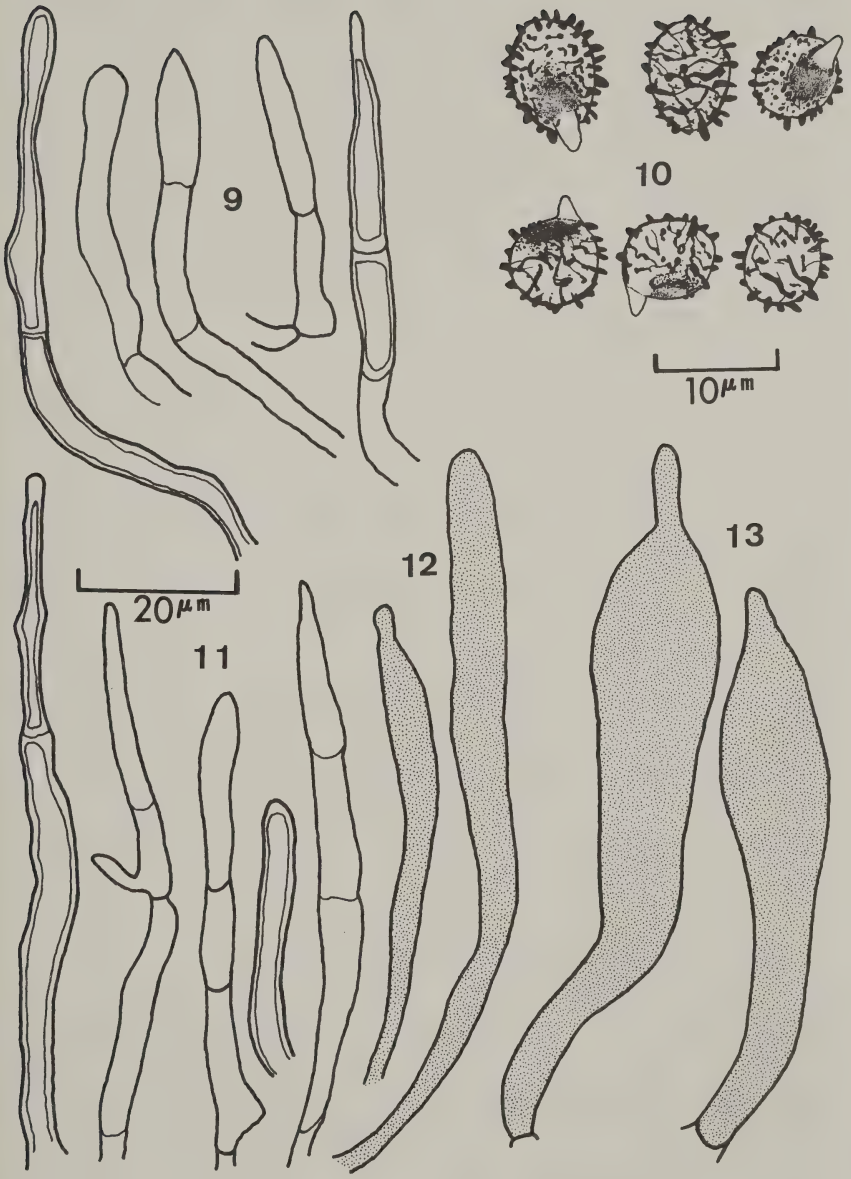
FIGS. 6-8. *Russula*. 6. *R. redolens* (GB 415), X3/5. 7. *R. granulata* (GB 439), X1/2. 8. *R. betularum* (GB 447), X4/5.

Chemical reactions (stipe trama): Formalin-no reaction to slowly pale pink; SV-no reaction; NH_4OH-no reaction; $FeSO_4$-no reaction to pale or medium pink; gum guaiac-quickly greenish blue; phenol-pale maroon to dark grayish maroon; aniline (lamellae)-yellow in 10 min.

Basidiospores pale yellowish white (Romagnesi I b, II a) in mass, 7-8.5(-9.5) X 5.5-7(-7.7) µm, obovate to broadly obovate; ornamentation amyloid, up to 1.2 µm high, mostly 0.3-0.7 µm high, consisting of crowded spines and conical verrucae, a few low, obtuse verrucae and scattered fine particles, sometimes verrucae forming short chains, connected by a few to many fine, low lines, forming a partial to nearly complete reticulum; suprahilar area depressed, occasionally unornamented, usually with a low, diffuse, irregular amyloid patch, with fine particles sometimes superimposed, often bordered by fine verrucae or particles. Basidia 29-51 X 8-12 µm, clavate, 4-sterigmate. Hymenial cystidia 50-97 X 9-17 µm, cylindrical, clavate to ventricose-rostrate, with rounded to acuminate apices, projecting up to 30 µm beyond basidia, arising from trama, subhymenium or hymenium, with highly refractive, hyaline to pale yellow contents in KOH, gray, purplish gray or greenish gray in SV. Subhymenium 20-25 µm thick, pseudoparenchymatous. Lamellar trama composed of sphaerocysts, connective hyphae and a few, scattered laticifers.

Pileus cuticle 145-240 µm thick, two-layered, without gelatinous materials; epicutis 50-150 µm thick, a trichodermium consisting of ascending to erect hyphae and scattered dermatocystidia, either forming a continuous trichodermium or with hyphal ends aggregated or agglutinated into fascicles by an amorphous incrusting material; terminal epicuticular hyphae 8-48 X 3-7 µm, cylindrical, narrowly clavate, acicular to aculeate, sometimes irregularly lobed, thin- to thick-walled, with highly branched and closely septate bases, hyaline to yellow in KOH; incrusting material amorphous, hyaline to pale yellow in water, slowly soluble in dilute base, with weak acid-resistant carbol fuchsin staining; dermatocystidia 50-140 X 5-8 µm, clavate to cylindrical, apices rounded to acuminate, completely to partially filled with hyaline refractive contents, hyaline to pale gray in SV, arising as extensions of the laticiferous hyphae from the trama or subcutis; subcutis 65-100 µm thick, composed of inflated cells that often form a pseudoparenchymatous zone, densely interwoven hyphae and scattered laticifers; inflated cells subglobose to irregularly lobed, up to 20 µm in diam; hyphae highly branched, often irregularly lobed or inflated, closely septate, 4-10 µm in diam, hyaline to pale yellow in KOH; laticifers flexuous, septate, 4-6 µm in diam, with refractive contents in KOH, hyaline to pale gray in SV. Pileus trama consisting of sphaerocysts, connective hyphae and laticifers.

Stipe cuticle similar to pileus cuticle, 60-90 µm thick, consisting of a thin layer of interwoven, ascending hyphae that gives rise to a trichodermium or fascicles of erect hyphae, with occasional protruding laticifers; hyphae cylindrical, with acicular to aculeate ends, often thick-walled, septate, highly branched at the bases, hyaline to yellow in KOH, often agglutinated or incrusted together; incrusting material


9
10
10µm
20µm
11
12
13

FIGS. 9-13. *R. ochroleucoides* (GB 635). 9. Hyphal ends from stipe surface. 10. Basidiospores. 11. Hyphal ends from pileus cuticle. 12. Dermatocystidia. 13. Hymenial cystidia.

the same as in pileus cuticle. Stipe trama consisting of nests of sphaerocysts, connective hyphae and laticifers.

Clamp connections absent from all tissues.

Habit, habitat and distribution. Solitary to gregarious on soil or humus in forests dominated by *Quercus* spp., *Carya* spp., *Fagus grandifolia* Ehrh., *Betula alleghaniensis* Britt., *B. lenta* L., *Tsuga canadensis* (L.) Carr., *Acer saccharum* Marsh. and *Rhododendron* spp. Reported from Newfoundland to Florida, westward to Michigan. Dr. Richard Homola informs me that it is fairly common under American beech in Maine. In Virginia and West Virginia, it is also common under American beech but can also be found in thin, dry oak-hickory forests. Fruiting June to October.

Material examined: U.S.A.: Alabama: Elmore Co., Robinson Springs, R. Burke 147 (FH). Florida: Alachua Co., Gainesville, W. A. Murrill 13 July 1944 (holotype of *R. levisporiformis*), W. A. Murrill 15 July 1938 (holotype of *R. levispora*), W. A. Murrill 11 June 1944 (holotype of *R. lutescentifolia*), W. A. Murrill 17 Oct 1932 (holotype of *R. subochroleuca*), (all FLAS). Maine: Washington Co., Springfield/Dansforth, R. L. Homola 6585 (MAINE). Michigan: Ann Arbor, C. H. Kauffman Aug 1913 (syntype, NY). Pennsylvania: Fayette Co., Ohiopyle, D. L. Pearth 29 July 1967 (NY); Monroe Co., Delaware Water Gap, OKM 20085 (VPI); Westmoreland Co., Powdermill Nature Reserve, L. K. Henry 23 July 1958 (NY). Tennessee: Unicoi Co., Roan Mt., L. R. Hesler 9096 (FH). Vermont: Windham Co., Newfane Hill, G. S. Burlingham 11-29 (holotype of *R. dura*, NY). Virginia: Giles Co., Mt. Lake, R. Singer V-180, V-263 (FH), Big Stony Creek, GB 639; Grayson Co., Wilburn Ridge, GB 876; Montgomery Co., near Christiansburg, GB 776, GB 785, GB 803, Luster's Gate, GB 772, (all VPI). West Virginia: Greenbrier Co., Beartown State Park, GB 808, Little Sewell Mt., GB 867; Pocahontas Co.; Lobelia, GB 904, Kennison Mt., GB 820; Randolph Co., Alpena Gap, GB 830; Tucker Co., Horseshoe Run, GB 834; Webster Co., Tea Creek, GB 811, (all VPI).

Observations. *Russula ochroleucoides* is common and widespread in eastern North America. It is easily recognized by the combination of a medium to large, dry, yellow to yellowish orange velvety to pruinose pileus, white to pale yellow stipe, the presence of thick-walled pileus and stipe cuticular hyphae that arise from a pseudoparenchymatous subcutis and SV$^+$ hymenial cystidia. It is similar to *R. flavida* Frost in Peck (see Bills and Miller, 1984 for a comparison). Singer (1957, 1975) placed this species in subsection *Amoeninae* because of its dry, pruinose pileus, acicular to aculeate epicuticular hyphal ends, pseudoparenchymatous subcutis and its similarities to *R. flavida*. Singer recognized that *R. ochroleucoides* was somewhat anomalous in the *Amoeninae* and placed it in its own stirps because of its SV$^+$ hymenial cystidia, pale cream spore deposit and yellow pigments. Contrary to Singer's observations, this species has dermatocystidia of the pseudocystidia (Singer, 1975) type.

Singer (1939) originally placed *Russula ochroleucoides* in subsection *Lepidinae*. It has some characters in common with the *Lepidinae* such as the shape, septation and incrustation of the epicuticular hyphae, bitter taste, dry velvety pileus, inseparable pileus cuticle and hard trama. Romagnesi (1967) once considered *R. lepida* var. *lactea* Möller and *R. ochroleucoides* to be the same taxon based upon previously published accounts of *R. ochroleucoides*. However after examining specimens of *R. ochroleucoides* from Pennsylvania, he concluded they were different. A specimen, with a watercolor painting, of *Russula lepida* var. *lactea* determined by J. Schaeffer (FH) is similar in cuticle structure to *R. ochroleucoides*, but has more abundant dermatocystidia, lacks thick-walled cuticular hyphae, differs in spore ornamentation and is much paler in pileus color.

Kauffman (1917) did not designate a type for *R. ochroleucoides* in his publication. However, he did write "Type" on the label of a a specimen from German Park Woods, near Ann Arbor, Michigan, 8 Aug 1912 (MICH).

Kauffman (1918: pl. XV) and Burlingham (1924: pl. 4, fig. 1, holotype of *R. dura*) published photographs of this species.

RUSSULA MODESTA Peck, *New York State Mus. Bull.* 116: 78. 1907.

FIGS. 3, 14-17

Pileus 3-10 cm broad, pulvinate, hemispherical to convex with incurved margin when young, plano-convex to plano-depressed, sometimes with margin uplifted in age; margin even, not striate when young, obscurely striate to sulcate-striate when mature; striations 2-10 mm long; cuticle separable about one-half way to disc; surface viscid when wet, especially near margin, soon dry, dull, usually densely pruinose over central one-fourth to three-fourths, sometimes radially streaked or with innate radial fibrils, often minutely rugulose, rarely with shallow areolate patches, dull gray, dull grayish green, brownish olive or grayish olive, Pale Olive-Buff, Olive-Buff, 4D3-2, 4C4-2, Drab, Isabella Color, 5D4-3, 5C4-3, Dark Olive-Gray, Deep Olive-Gray, Deep Mouse Gray, usually with disc entirely or variegated pale vinaceous brown, pinkish yellow, or grayish yellow, Light Pinkish Cinnamon, Light Vinaceous-Cinnamon, Vinaceous-Buff, Apricot Buff, Pinkish Buff, Avellaneous, Fawn Color, 7D5-4 7C5-4, 7B5-4, 6C4-3, Straw Yellow, Cream Color, 5B3, 3C3, 3B3, sometimes fading to pale grayish yellow near the margin, 4B3-2; trama firm and elastic when young, brittle in age, up to 5 mm thick at midradius, white, tinted gray just beneath cuticle, unchanging when cut; odor not distinctive or faintly fruity; taste not distinctive.

Lamellae adnate, close to medium in age, with lamellulae absent to scattered, forked or anastomosing near stipe, occasionally forked at other levels, intervenose, subacute in front, up to 9 mm broad at midradius, white when young, soon Cartridge Buff to pale yellow, 3A2, sometimes with yellowish brown discolorations or flecks; edges even, sometimes discolored yellowish brown in age.

Stipe 2.5-6 cm tall, 1-2.5 cm wide at midpoint, equal, expanded or tapered toward the base; surface dry, glabrous or faintly pruinose near apex, longitudinally rugulose, white, rarely with a faint pink tint near apex, sometimes discolored yellowish brown near base; trama solid to spongy, white, unchanging when cut.

Chemical reactions (stipe trama): Formalin-no reaction to pale pink; SV-no reaction to pale grayish lilac; $FeSO_4$-no reaction to pale grayish green or pale grayish pink; gum guaiac-bluish green; phenol-maroon.

Basidiospores pale yellow (Romagnesi II a-b) in mass, 6-7(-8.5) X 4.5-6(-6.8) µm, short-elliptical, obovate to broadly obovate; ornamentation amyloid, up to 0.8 µm high, mostly 0.3-0.5 µm high, crowded, consisting of blunt, obtuse verrucae and fine particles, with verrucae sometimes aligned in short catenulate ridges, with none to many fine connecting lines, forming a partial reticulum at most; suprahilar area depressed or not unornamented, with a few fine particles or bordered by fine particles and verrucae. Basidia 30-46 X 8-9.5 µm, narrowly clavate to clavate, 4-sterigmate. Hymenial cystidia 48-80 X 6.5-11 µm, projecting 5-40 µm beyond basidia, ventricose-rostrate, fusoid-ventricose to fusoid, with rounded to acuminate apices, arising from hymenium or subhymenium, with hyaline to pale yellow refractive contents in KOH, gray to greenish yellow in SV. Subhymenium 20-45 µm thick, pseudoparenchymatous. Lamellar trama composed of sphaerocysts and connective hyphae.

Pileus cuticle 60-180 µm thick, without gelatinous materials; epicutis 60-140 µm thick, consisting of interwoven, ascending to erect hyphae, short chains of inflated cells and two types of dermatocystidia, often forming a distinct "virescens-structure"; inflated cells highly variable in number, 6-20 X 5-14 µm, cylindrical to subglobose, absent to forming a distinct pseudoparenchymatous zone up to 70 µm thick, giving rise to erect, acicular to clavate dermatocystidia; dermatocystidia of two types: those arising from inflated cells, 8-65 X 5-14 µm, acicular, aculeate, subulate, cylindrical to clavate, thin-walled, hyaline to pale yellow in KOH, inert in sulfoaldehydes, without refractive contents; second type arising from subcutis or pileus trama, scattered to abundant, 35-90 X 4-7 µm, cylindrical to clavate, with rounded or slightly constricted apices, completely or partially filled with refractive contents, hyaline in KOH, pale gray to yellowish gray or greenish yellow in SV; subcutis absent to 40 µm thick, consisting of densely interwoven, horizontal hyphae, sometimes slightly gelatinized, appearing pale greenish yellow in KOH; hyphae 2-6 µm in diam, septate, with abundant to scattered grayish green to dark gray, pigmented cytoplasmic granules (in water). Pileus trama composed of sphaerocysts, connective hyphae and occasional laticifers; laticifers 4-7 µm in diam, hyaline to pale gray in SV.

Stipe cuticle 50-85 µm thick, a thin layer of interwoven, horizontal to ascending hyphae and caulocystidia; caulocystidia 20-65 X

4-7 µm, cylindrical to narrowly clavate, with rounded to tapered apices, partially or completely filled with refractive contents, hyaline to pale yellow in KOH, hyaline to pale gray in SV; hyphae mostly 2-5 µm in diam, with some irregularly shaped, inflated cells up to 14.5 µm in diam. Stipe trama composed of nests of sphaerocysts and connective hyphae.

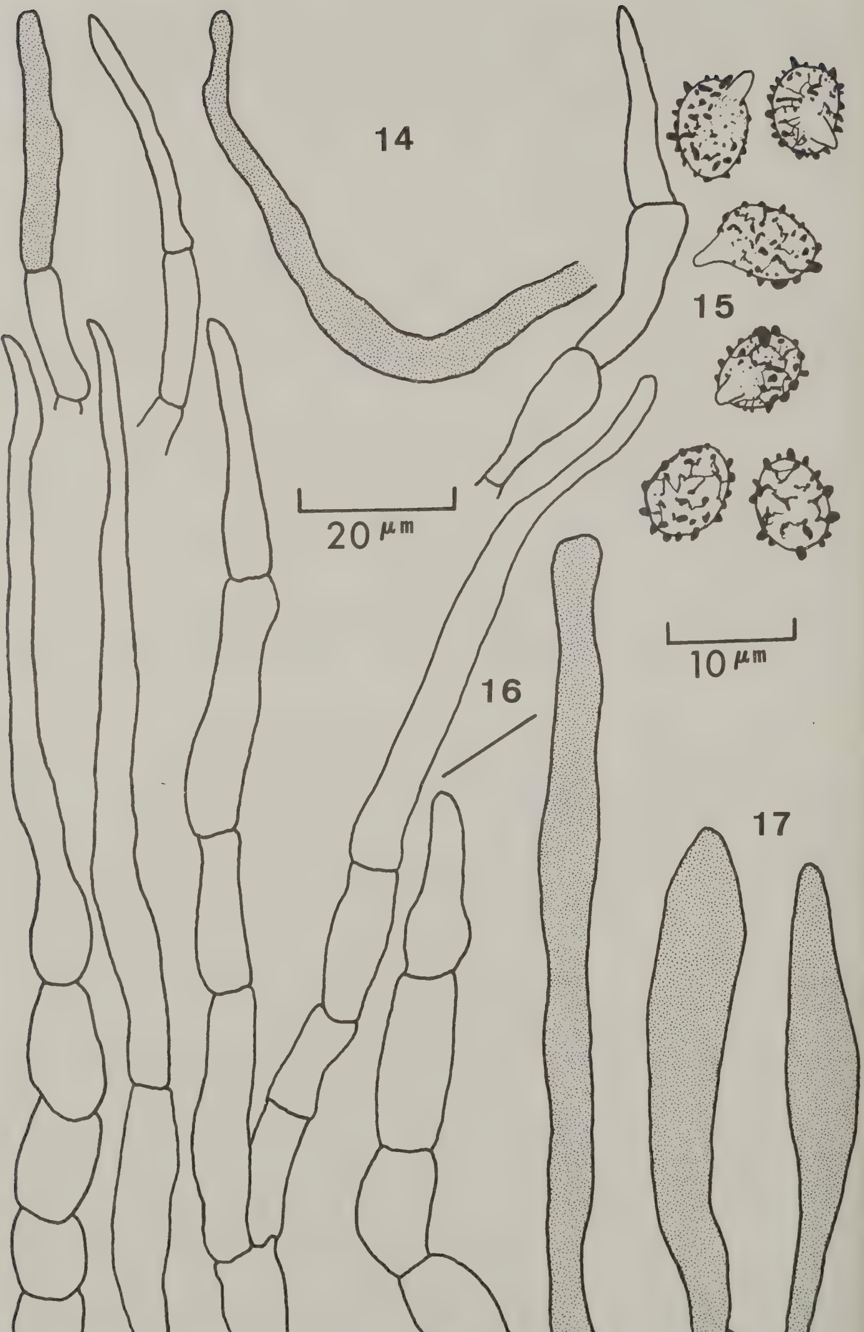
Clamp connections absent in all tissues.

Habit, habitat and distribution. Scattered to gregarious on humus under *Fagus grandifolia*, *Betula alleghaniensis*, *Quercus rubra* L., *Picea rubens* Sarg., *Tsuga canadensis*, *Acer saccharum* and *Rhododendron maximum* L. Known from New England southward to mountainous regions of West Virginia, Virginia and Tennessee. Fruiting July to September.

Material examined: U.S.A.: Massachusetts: Worcester Co., T. L. Smith, July 1906 (NYS). New York: Albany Co., Menands, C. H. Peck, 20 July 1906 (holotype, NYS); Oswego Co., H. D. House 14.107 (NYS). Tennessee: Sevier Co., Grassy Patch, GSMNP, A. H. Smith 10426 (FH, MICH). Virginia: Grayson Co., Headwaters of Big Wilson Creek, GB 882, Pine Mt., GB 441, (both VPI). West Virginia: Nicholas Co., Cranberry River, GB 871; Pocahontas Co., Black Mt., GB 622, Sugar Creek Mt., GB 150; Randolph Co., Headwaters of Otter Creek, GB 829; Tucker Co., Canaan Mt., GB 836, Fisher Spring Run, Dolly Sods Wilderness Area, GB 845; Webster Co., Tea Creek, GB 813, (all VPI).

Observations. This description is based upon collections from the Southern Appalachians. These populations were previously referred to *R. modesta* when Singer (1939) published a description of two of A. H. Smith's collections from the GSMNP, which are identical with my material from Virginia and West Virginia. The Southern Appalachian specimens differ slightly from Peck's type material, in which the dermatocystidia arising from the inflated basal cells have thickened walls and the dried sporocarps are yellower. This latter character may be an artifact. From an extensive survey of herbarium material and consultation with several mycologists, I was unable to obtain any information on fresh characters of *R. modesta* from the northeastern United States. For the time being, the Southern Appalachian populations should be retained under the name *R. modesta*. Although data from fresh material from the Northeast may eventually indicate they are different species.

Singer's (1957) description of *R. modesta* was apparently based upon specimens from Florida. These specimens (FH) are distinctly different from the New York and Appalachian material and represent another closely related species. They lack the characteristic, persistent, well-developed bloom over the disc and have a thicker pseudoparenchymatous zone in the epicutis, which resulted in the development of a cracked, areolate pileus surface in some of the specimens. Also, the Florida specimens have a lower, more crowded, more reticulate spore ornamentation.


20 µm
10 µm

The pileus cuticle of *R. modesta* has features in common with that of the subsections *Virescentinae*, *Amoeninae* and *Griseinae* (Singer, 1943, 1957). The long, acicular to subulate dermatocystidia arising from inflated basal cells are homologous with the terminal epicuticular cells of other species in Romagnesi's supersection *Heterophyllae*. Some *Russula* specialists have referred to these elongated terminal cells as "poils" or epicuticular hairs (Singer, 1943; Romagnesi, 1967). Some agaricologists would consider them to be dermato- or pileocystidia. In *R. modesta*, they are very similar to those of *R. mariae* Peck and other members of the subsection *Amoeninae*. Singer (1949) originally included *R. modesta* in stirps *Modesta* within subsection *Amoeninae* because of these similarities in cuticular structure but recognized that it was different from the other members of the group because of the presence of weakly SV+ dermatocystidia of the pseudocystidia type. In 1957, he elevated the stirps *Modesta* to subsection *Modestinae*. *Russula modesta* is also similar to the *Virescentinae* because of the sometimes thick pseudoparenchymatous zone in the epicutis. The pigmented cytoplasmic granules of the cuticular hyphae and weakly SV+ dermatocystidia are characters in common with members of the *Griseinae*. I agree with Singer that *R. modesta* represents a species morphologically intermediate among the *Virescentinae*, *Amoeninae* and *Griseinae*. Its placement within the infrageneric classification of *Russula* must await a comprehensive world-wide treatment of the supersection *Heterophyllae*.

Russula modesta is one of the most common Russulas in the mixed northern hardwood-red spruce forests of West Virginia and Virginia. Many more fresh specimens have been examined in the field than the "Material examined" indicates. The dense white pruinose bloom, variable pileus coloration, pale yellow spore deposit and long subulate to acicular dermatocystidia arising from short chains of inflated cells are its most distinctive features.

RUSSULA POLYCYSTIS Singer, *Bull. Soc. Mycol. France* 55: 238. 1939.
FIGS. 4, 18-20

Pileus 4-10 cm broad, convex with incurved margin, plane to plano-depressed; margin striate to tuberculate-striate; striations 5-9 mm; cuticle separable nearly to disc, thick, gelatinous, elastic or rubbery; surface viscid, shiny, fragmenting into areolate, crustose or scurfy patches during pileus expansion, with areolate patches embedded in a gelatinous material, pale yellow, Cream Color, Cream-Buff, Cartridge Buff, Ivory Yellow, Maize Yellow, Straw Yellow, 4A4-3, 4B4-3 to pale yellowish brown, Cinnamon-Buff at the disc; trama firm, elastic, up to 4 mm thick at midradius, white, unchanging; odor none; taste slowy acrid.

FIGS. 14-17. *R. modesta* (GB 150). 14. Hyphal ends and caulocystidia from stipe cuticle. 15. Basidiospores. 16. Dermatocystidia. 17. Hymenial cystidia.

Lamellae adnate, close to medium, occasionally forked near the stipe, with a few scattered lamellulae, intervenose, up to 4.5 mm broad at midradius, acute to subacute in front, white to pale yellow (Romagnesi I b, II a), with pale yellowish brown spots in age, slowy bruising yellowish brown; edges even.

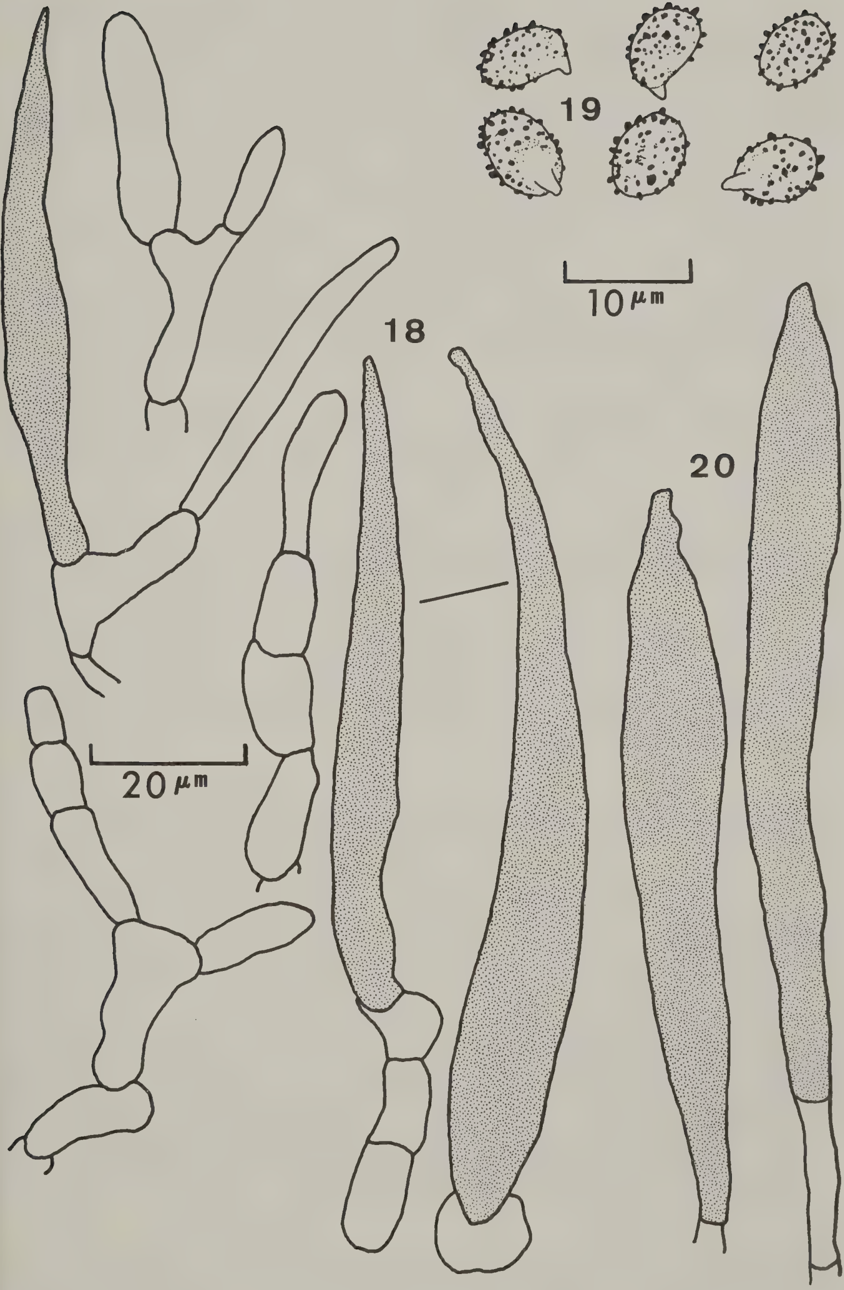
Stipe 2.5-6 cm tall, 1-2 cm wide at midpoint, equal or tapered toward the base, sometimes slightly fluted at apex; surface dry, minutely pruinose or scurfy over entire length, longitudinally rugulose, white to pale yellow, discoloring dingy pale brown with excessive handling; trama solid to chambered, firm but brittle, white, unchanging.

Chemical reactions (stipe trama): SV-no reaction; $FeSO_4$-grayish pink; gum guaiac-greenish blue; phenol-grayish maroon; aniline(lamellae)-pale yellow in 10 min.

Basidiospores pale cream (Romagnesi I b, II a) in mass, 6.5-7.5(-8) X 5-6.5 µm, obovate to elliptical; ornamentation amyloid, up to 1 µm high, consisting of isolated, obtuse to conical verrucae and fine particles, rarely a few, fine lines connecting two to three verrucae; suprahilar area slightly depressed or not, unornamented or ornamented with fine particles. Basidia 36-59 X 8.5-9.5 µm, narrowly clavate to clavate, 4-sterigmate. Hymenial cystidia 55-120 X 9.5-13.5 µm, projecting 10-45 µm beyond basidia, abundant, ventricose-rostrate, fusoid-ventricose to lanceolate, with mucronate, acuminate or appendiculate apices, arising deep within trama or subhymenium, with highly refractive contents, hyaline to pale yellow in KOH, greenish yellow, greenish purple or purple in SV. Subhymenium 20-35 µm thick, pseudoparenchymatous, sometimes appearing partially gelatinized. Lamellar trama composed of abundant connective hyphae and relatively few sphaerocysts.

Pileus cuticle two-layered, extremely thick, 600-800 µm thick; epicutis 100-200 µm, an ixotrichodermium of a "virescens-structure", similar in structure to epicutis of *R. crustosa* Peck, composed of inflated cells that form a pseudoparenchymatous zone and give rise to a turf of erect dermatocystidia; inflated cells 10-31 X 5-15 µm, subglobose, pyriform to short-cylindrical dermatocystidia 75-154 X 9-16 µm, fusoid-ventricose, fusiform to lanceolate, with acuminate, mucronate or appendiculate apices, aseptate, with highly refractive or coagulated contents, hyaline to yellow in KOH, hyaline to pale gray in SV. Subcutis 450-650 µm thick, gelatinous, consisting of loosely interwoven, horizontal to ascending hyphae; hyphae usually very thin, 1-4.5 µm in diam, contorted, flexuous, sparsely branched, septate, hyaline in KOH. Pileus trama composed of sphaerocysts, connective hyphae and scattered laticifers; laticifers flexuous, 4-9 µm in diam, with refractive contents in KOH, pale pinkish violet in SV.

Stipe cuticle 45-100 µm thick, a thin layer of interwoven hyphae and laticifers that give rise to a sparse turf of caulocystidia; hyphae 2-4.5 µm in diam, septate, branched; caulocystidia similar to


19
10 µm
18
20
20 µm

FIGS. 18-20. *R. polycystis* (GB 449). 18. Hyphal ends and dermatocystidia from pileus cuticle. 19. Basidiospores. 20. Hymenial cystidia.

dermatocystidia, 70-110 X 9-14.5 µm, fusoid-ventricose to lanceolate with acuminate to mucronate apices, with highly refractive contents, hyaline to pale yellow in KOH, hyaline to pale yellowish gray in SV; laticifers confined to stipe surface, flexuous, 6-14 µm in diam, hyaline to pale yellow in SV. Stipe trama consisting of nests of sphaerocysts and connective hyphae.

Clamp connections absent in all tissues.

Habit, habitat and distribution. Gregarious on humus, in forests of *Picea rubens*, *Betula alleghaniensis*, *Tsuga canadensis* and *Rhododendron* spp. Presently, known only from high mountain regions of West Virginia, Virginia and Tennessee, but probably occurring throughout Southern Appalachian *Picea rubens* communities.

Material examined: U.S.A: Tennessee: Sevier Co., Mt. LeConte, GSMNP, A. H. Smith 10481 (holotype, MICH). Virginia: Grayson Co., Headwaters of Big Wilson Creek, GB 878 (VPI). West Virginia: Pocahontas Co., Cranberry Glades, GB 449 (VPI).

Observations. *Russula polycystis* had never been reported occurring beyond the type locality. Its most distinctive feature is the thick gelatinous cuticle with the outer layers fragmenting during pileus expansion to form areolate or scurfy patches. However, the areolate pileus may be obscured by the abundant gelatinous material. In addition, it has pale yellow to buff pileus colors and a pileus and stipe covered with large, highly refractive cystidia. It is unusual that only the hymenial cystidia react in SV when the cuticular cystidia are so similar in shape and content.

This species is difficult to place within the genus. At first glance in the field, it resembles a member of the section *Ingratae*. It was originally placed in the subsection *Virescentinae* (Singer 1939, 1942). The epicutis is similar to that of the *Virescentinae* because of the thin pseudoparenchymatous zone that gives rise to a turf of dermatocystidia. The elliptical spores, ornamented with isolated, obtuse verrucae, are similar to those of *R. chlorinosma* Burlingham of the *Virescentinae*. The enormous dermatocystidia with refractive contents and the thick gelatinous subcutis are unlike those of any other species in the *Virescentinae*. Later, Singer (1975) placed this species in his subsection *Polyphyllinae* with *R. polyphylla* Peck and *R. viridella* Peck because of the highly refractive contents of the dermatocystidia and the scurfy, areolate pileus surface. Other than this similarity in cystidia contents, there is little in common among these fungi. For now, I prefer to retain *R. polycystis* in the *Virescentinae* because of the pseudoparenchymatous layer of the epicutis.

RUSSULA REDOLENS Burlingham, *Mycologia* 13: 133. pl. 7, fig. 6 & fig. 6. 1921. FIGS. 6, 21-24

Pileus 2-6 cm broad, plane to plano-depressed, with margin uplifted in age; margin faintly striate to striate; striations 1-4 mm long; cuticle easily separable one-half to two-thirds way to the disc; surface viscid and shiny when wet, minutely rugulose or radially rugulose under a lens, sometimes with a faint canescent bloom near the margin, dark bluish green, grayish blue-green to grayish green, Myrtle Green, Terre Verte, Dark Terre Verte, Dusky Green, Dusky Blue-Green, Light Porcelain Green, Niagara Green, 25E3, 25D3, 24E3, 24D3, 21D4, 21D3, 20C2, often variegated with pale yellow, pale yellowish pink to lavender, especially over the disc, Cream-Buff, Buff-Pink, Lavender, 5B3, 4B2, 3B2; trama brittle, up to 3 mm thick at midradius, white, slightly gray underneath the cuticle, unchanging when cut; odor mild to disagreeable in age, of parsley (*Petroselinum* spp.) or celery (*Apium graveolens* L.) when drying; taste mild to disagreeable or nauseous, often with a strong aftertaste of parsley or celery.

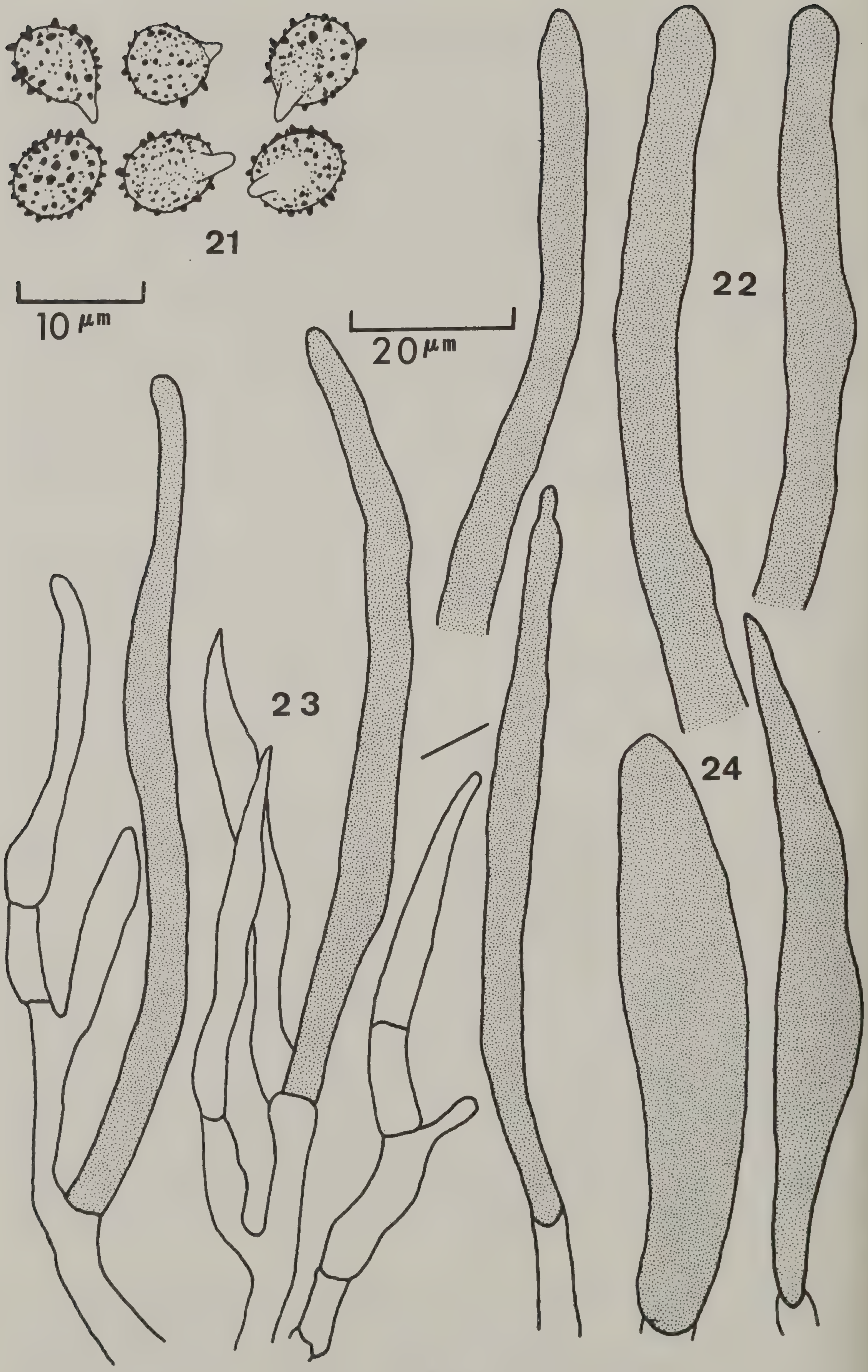
Lamellae adnate to subdecurrent, crowded, often forked near the stipe, with occasional lamellulae, subacute to rounded in front, up to 5 mm broad at midradius, white when young, pale yellow (Romagnesi II a) in age; edges even.

Stipe 3-7 cm tall, 1-1.8 cm wide at midpoint, equal, or flared at the apex and tapered toward the base; surface dry, dull, sometimes minutely pruinose at the apex; longitudinally rugulose, white, rarely partially pale grayish green, 25B2; sometimes dingy, pale gray with handling; trama spongy to hollow, white, unchanging when cut.

Chemical reactions (stipe trama): gum guaiac-no reaction to bluish green; $FeSO_4$ -pale grayish pink to salmon; phenol-maroon; aniline (lamellae)-pale yellow in 10 minutes.

Basidiospores white to pale yellowish white (Romagnesi I a-b) in mass, 6-8 X 4.5-6 µm, subglobose, obovate to short-ellipsoid; ornamentation amyloid, up to 1 µm high, mostly 0.3-0.7 µm high, consisting of isolated, obtuse, hemispherical to subconical verrucae and fine particles, crowded to widely spaced, with connectives absent to rare; suprahilar area depressed or not, unornamented or with fine particles. Basidia 32-58 X 9-12 µm, clavate, 4-sterigmate. Hymenial cystidia 60-85 X 8-10 µm, projecting up to 20 µm beyond basidia, cylindrical, lanceolate or fusoid, with rounded, acuminate or mucronate apices, arising from the trama or subhymenium, with hyaline refractive contents in KOH, greenish purple in SV. Subhymenium 15-30 µm thick, pseudoparenchymatous. Lamellar trama composed of sphaerocysts and connective hyphae, without laticifers.

Pileus cuticle 280-370 µm thick, gelatinous, two-layered; epicutis 135-180 µm thick, a trichodermium, not well differentiated from subcutis, composed of ascending to erect hyphae and dermatocystidia; hyphae often highly branched, septate, 2-6.5 µm in diam, with ends


21
10 µm
20 µm
22
23
24

FIGS. 21-24. *R. redolens* (GB 444). 21. Basidiospores. 22. Caulocystidia. 23. Hyphal ends and dermatocystidia from pileus cuticle. 24. Hymenial cystidia.

rounded, tapered to subulate, with scattered to abundant greenish gray to dark gray pigmented cytoplasmic granules (in water); dermatocystidia abundant, 65-240 X 6-9 µm, cylindrical to narrowly fusoid, with rounded, tapered, acuminate or constricted apices, aseptate, arising in epicutis or subcutis, with hyaline refractive contents in KOH, hyaline to pale greenish violet in SV; subcutis 180-240 µm thick, composed of horizontal to ascending, interwoven hyphae; hyphae branched, septate, 2-6 µm in diam. Pileus trama composed of sphaerocysts and connective hyphae; laticifers absent.

Stipe cuticle thin, 25-50 µm thick, composed of horizontal, interwoven hyphae and caulocystidia; hyphae branched, septate, 2-4.5 µm in diam; caulocystidia appressed to stipe surface, very abundant, 35-210 X 6-10 µm, cylindrical to narrowly clavate, with rounded or slightly constricted apices, aseptate, with hyaline refractive contents in KOH, pale grayish green to pale greenish violet in SV. Stipe trama composed of nests of sphaerocysts and connective hyphae; laticifers absent.

Clamp connnections absent from all tissues.

Habit, habitat and distribution. Solitary to gregarious on humus in mesic northern hardwood forests or northern hardwood-red spruce transition zones. These forests dominated by *Fagus grandifolia*, *Betula alleghaniensis*, *Quercus rubra*, *Tilia americana* L., *Acer saccharum*, *A. pensylvanicum* L. , *Prunus serotina* Ehrh. and *Fraxinus americana* L. Fruiting late July to late August. Presently known only from Vermont, eastern West Virginia and southwestern Virginia, but probably more widely distributed within the above forest types in eastern North America.

Material examined: U.S.A.: Vermont: Windham Co., Newfane Hill, G. S. Burlingham 77-1916 (holotype, NY). Virginia: Giles Co., Mt. Lake, GB 889; Grayson Co., Headwaters of Big Wilson Creek, GB 887, (both VPI). West Virginia: Greenbrier Co., Little Sewell Mt., GB 864; Pendleton Co., Seneca Creek, GB 848; Pocahontas Co., Briery Knob, GB 902, Kennison Mt., GB 152, GB 415, GB 444; Randolph Co., Glady Fork, GB 827; Summers Co., Pipestem, R. Vilgalys 4 Aug 1984; Tucker Co., Horseshoe Run, (all VPI).

Observations. *Russula redolens* is a poorly known species that has never been reported since its original description. Burlingham collected Russulas in Windham Co., Vermont, for many years and accumulated several collections of most of the species she described from the area. *Russula redolens* seems to be an exception to this. Other than the holotype, only one other specimen labled *R. redolens* which was identical with the type was found in her herbarium. This specimen was without data about its collection location and its fresh characters. Singer (1942) studied another Burlingham specimen, 15-1917 (NY), labeled *R. redolens* and concluded that its infrageneric position could not be determined without information on the fresh condition of the sporocarps. I compared this specimen with the holotype and found it to be an unrelated species. Fortunately, Anne Hibbarde made a watercolor painting of the holotype which is preserved in the Archives of the New York Botanical Garden. The color plate accompanying the original description was reproduced from this painting. In the *Mycologia* plate, the green color of the pileus was much brighter and purer than the dull gray-green (Dusky Green, Slate-Olive to Tea Green) of the original watercolor. Perhaps the inaccurate color of the *Mycologia* plate was part of the reason this species had not been reported again.

Specimens from the Southern Appalachians agree well with the original painting in both color and stature. However, the original description and painting were based on only a few sporocarps and did not indicate the entire color range of the pileus. Many of the Southern Appalachian specimens had dark to light bluish green colors that were not previously indicated. The pale grayish green stipe was seen only the collections from Pipestem, West Virginia and Mt. Lake, Virginia. Microscopically, my material is identical with Burlingham's type.

Russula redolens is a typical member of the subsection *Griseinae*. Its distinguishing features are the combination of relatively small sporocarps, dark bluish green to grayish green pileus often with a faded, light pinkish buff to lavender disc, white spore deposit, nauseous taste with a strong parsely or celery aftertaste, abundant, long, cylindrical, weakly SV^+ dermato- and caulocystidia and spores ornamented with isolated, predominately obtuse verrucae.

RUSSULA BRUNNEOLA Burlingham, *N. Amer. Fl.* 9: 233. 1915. FIG. 6

This species has been described in detail by Singer (1957) and Shaffer (1970). Shaffer also provided excellent illustrations of its important microscopic features. A photograph of sporocarps is provided here to supplement these previous studies. *Russula brunneola* has been reported from Washington State and throughout the northeastern United States and southeastern Canada. This species has now been observed in the higher elevations of the Southern Appalachian Mountains. I have collected it in forests of *Picea rubens* and mixed forests of *P. rubens, Abies fraseri* Poir., *Betula alleghaniensis* and *Fagus grandifolia*. It probably occurs throughout these forests types from West Virginia to southern North Carolina. The southernmost specimen I have seen was collected under *Tsuga canadensis* at Highlands, North Carolina (L. R. Hesler 24698).

I follow the classification of Romagnesi and place this species in his section *Heterophyllinae* which includes the closely related *R. vesca* Fr. and *R. mustelina* Fr. Using the keys of Romagnesi, I initially determined this species as *R. mustelina* because of its strong orange-red reaction in $FeSO_4$, lemon-yellow reaction in aniline, dark brown colors and habitat in mountainous coniferous forests. However, the presence of *R. mustelina* in North America has never been documented.

Material examined: U.S.A.: North Carolina: Macon Co., Highlands, L. R. Hesler 24698 (TENN); Yancey Co., Mt. Mitchell, GB 621 (VPI). Vermont: Windham Co., Stratton, G. S. Burlingham 99-1911 (holotype, NY). Virginia: Grayson Co., Cabin Ridge, GB 315, Mt. Rogers, GB 674 (both VPI). West Virginia: Pocahontas Co., Briery Knob, GB 912 (VPI).

RUSSULA GRANULATA (Peck) Peck, *Annual Rep. New York State Museum* 53: 843. pl. C, figs. 1-5. 1901. FIG. 7

Russula granulata is widely distributed in southeastern Canada and northeastern United States and extends southward through the higher elevations of the Southern Appalachian Mountains. It has been reported from the higher elevations of the GSMNP (Singer, 1957; Shaffer, 1972) and from near the summit of White Top Mt. which is coverd by a red spruce forest in southwestern Virginia (Singer, 1957). *Russula granulata* is the most abundantly fruiting *Russula* in high-elevation red spruce and northern hardwood forests in southeastern West Virginia (Bills, unpublished data), occuring with nearly the same frequency in both forests types. In this area, its fruiting season starts in late June and extends into early September with the peak sporocarp production in late July and early August. I have observed it fruiting abundantly on surface mines reforested with *Picea abies* (L.) Karst. *Russula granulata* also fruits in cove eastern hemlock forests at lower elevations (about 850 M). Singer (1957) noted that this species was non-selective in its habitat and fruited in both coniferous and hardwood forests. Personal observations and notes with herbarium specimens indicate *R. granulata* may be associated with *Picea rubens*, *P. mariana* (Mill.) B.S.P., introduced *P. abies*, *Abies balsamea* (L.) Miller, *A. fraseri*, *Tsuga canadensis*, *Fagus grandifolia*, *Betula alleghaniensis*, *B. papyrifera* Marsh. and *Quercus rubra*.

Shaffer (1972) provided a thorough and detailed description of *R. granulata*. It is one of the most easily identified members of the subsection *Foetentinae*. The combination of small to medium sporocarps with a relatively squat stature, a viscid yellowish brown to tawny-brown pileus with crustose patches forming over the disc as the outer cuticle fragments and spores ornamented with mostly isolated, obtuse to conical verrucae make this a distinctive species.

Material examined: U.S.A.: New York: Ulster Co., Denning, C. H. Peck, Aug (holotype, NYS). Tennessee: Sevier Co., Indian Gap, GSMNP, L. R. Hesler 20974 (TENN). Virginia: Bland Co., Burke's Garden Mt., GB 297; Grayson Co., Pine Mt., GB 439, (both VPI). West Virginia; Pocahontas Co., Cranberry Glades, GB 198, Kennison Mt., GB 125, Sugar Creek Mt., GB 149; Randolph Co., Headwaters of Otter Creek, GB 824; Tucker Co., Canaan Mt., GB 835; Webster Co., Tea Creek, GB 804, (all VPI).

RUSSULA BETULARUM Hora, *Trans. Brit. Mycol. Soc.* 43: 456. 1960. FIGS. 8, 25-29

Russula emetica var. *betularum* (Hora) Romagnesi, *Les Russules*, p. 401. 1967.

Pileus up to 4 cm broad, plane, plano-depressed or deeply depressed; margin straight to uplifted, striate to tuberculate-striate; striations 1-3 mm long; cuticle separable nearly to disc; surface viscid when wet, shiny, minutely rugulose to smooth, predominately white to pale pink, 9A2, 8A2 over outer two-thirds, pale yellowish pink, pale yellow to yellowish olive, 1A2, 2A2 over the disc; trama fragile, water-soaked, thin, up to 2 mm thick at midradius, white to pale yellowish gray; odor mild; taste acrid.

Lamellae adnate to slightly adnexed, medium, intervenose, occasionally forked near stipe, up to 3.5 mm wide at midpoint, subacute in front, white when young, pale grayish yellow in age; edges even to minutely serrate.

Stipe up to 3.8 cm tall, up to 1.1 cm wide at midpoint, equal or slightly expanded toward the base; surface dry to moist, glabrous, longitudinally rugulose, white to pale grayish yellow; trama fragile, stuffed, white, often water-soaked, unchanging when cut.

Chemical reactions (stipe trama): SV-reddish violet; gum guaiac-slowly bluish green; phenol-grayish maroon; $FeSO_4$ -grayish pink to pinkish orange; aniline (lamellae)-yellow in 10 minutes.

Basidiospores white to faintly yellowish white (Romagnesi I a-b) in mass, 8-10.5(-12) X 6.5-8(-9) µm, broadly obovate to subglobose; ornamentation amyloid or with verrucae having inamyloid cores, up to 1 µm high, consisting of crowded, obtuse to conical verrucae, a few to many scattered fine particles, with verrucae sometimes aligned into short catenulate chains, usually highly interconnected by fine to moderately broad, low lines, with lines often forming a dense network; suprahilar area depressed, usually with broad, diffuse to dark, irregular, amyloid patch, bordered by many fine particles or with many fine lines radiating outward from the border. Basidia 32-45 X 11-14 µm, broadly clavate to clavate, 4-sterigmate, rarely 2-sterigmate. Hymenial cystidia abundant, 53-90 X 9-12 µm, fusiform to narrowly clavate, with acuminate, mucronate or occasionally appendiculate apices, projecting up to 40 µm beyond basidia, arising from hymenium or subhymenium, with hyaline refractive contents in KOH, greenish purple to grayish purple in SV. Subhymenium 12-20 µm thick, pseudoparenchymatous. Lamellar trama composed of sphaerocysts, connective hyphae and abundant laticifers; laticifers flexuous, septate, 4-10 µm in diam, grayish purple in SV.

Pileus cuticle 95-130 µm thick, gelatinous, two-layered; epicutis 70-100 µm thick, a trichodermium consisting of erect, tangled, filamentous hyphae and dermatocystidia; epicuticular hyphae 2-4.5 µm in diam, highly branched, closely septate, with blunt apices;

dermatocystidia abundant, 18-145 X 7-12 µm, broadly clavate to clavate, sometimes cylindrical, usually with broad obtuse apices, occasionally with tapered or constricted apices, 0-4 septate, arising from epicutis, subcutis or upper trama, with hyaline refractive contents in KOH, pale to dark purple or blackish purple in SV; subcutis 24-36 µm thick, consisting of interwoven, horizontal hyphae and laticifers; hyphae septate, branched, 2-6 µm in diam. Pileus trama composed of sphaerocysts, connective hyphae and abundant laticifers; laticifers flexuous, septate, 5-14 µm in diam, with hyaline refractive contents in KOH, grayish purple in SV.

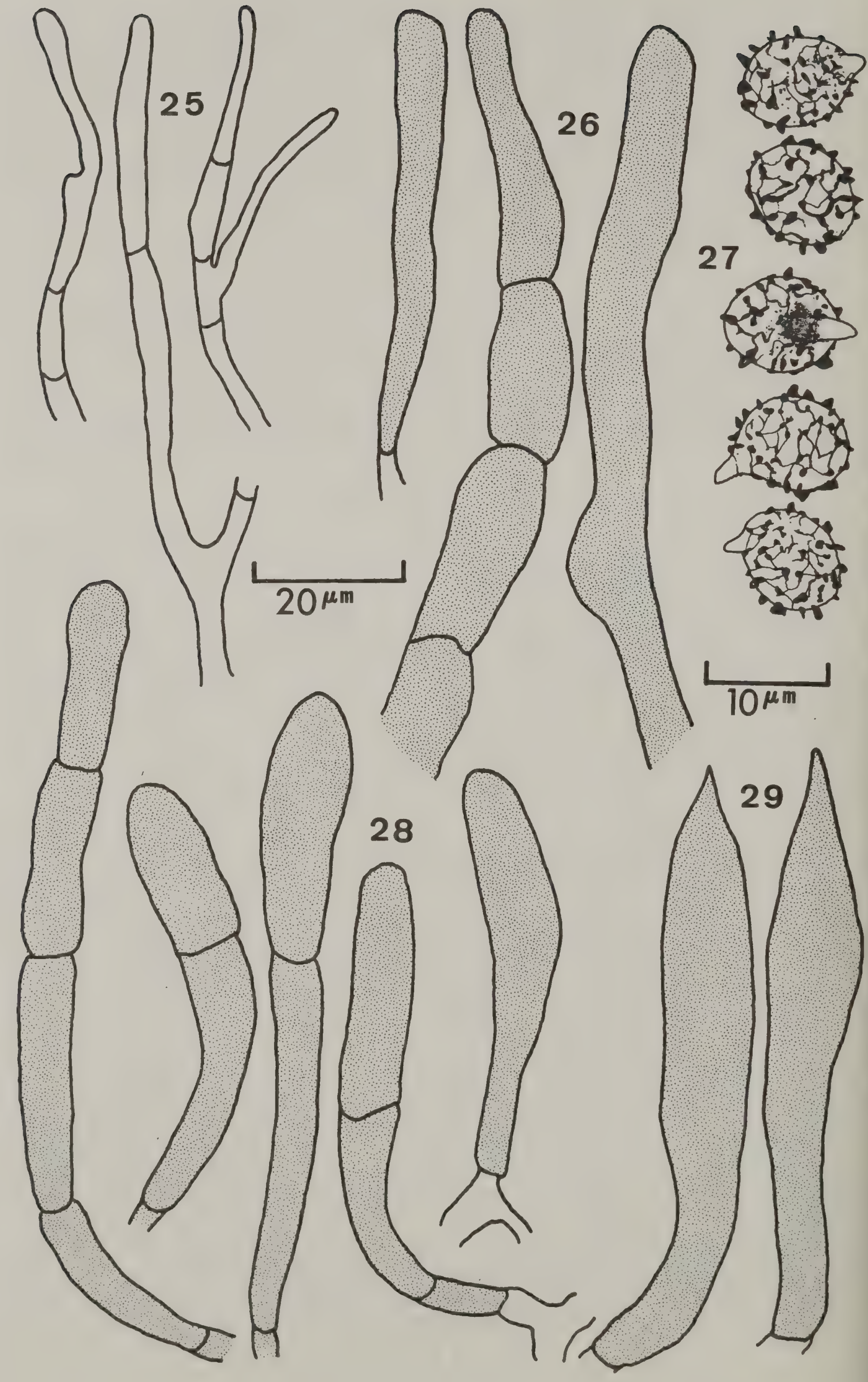
Stipe cuticle 30-70 µm thick, consisting of horizontal to ascending, tangled, filamentous hyphae, caulocystidia and laticifers; hyphae branched, septate, 2-7 µm in diam; caulocystidia abundant, 45-165 X 6-9 µm, clavate to cylindrical, with rounded to slightly narrowed apices, 0-4 septate, with hyaline refractive contents in KOH, pale greenish purple to blackish purple in SV. Stipe trama composed of sphaerocysts, connective hyphae and laticifers.

Clamp connections absent in all tissues.

Habit, habitat and distribution. Apparently this is the first report of this species in North America where it has been found in eastern West Virginia and southwestern Virginia. It is known from birch and birch-spruce forests of western Europe. Most of the collections described above were solitary to scattered on humus in forests of *Betula alleghaniensis*, *Picea rubens*, *Tsuga canadensis* and *Rhododendron* spp. or in stands of *Betula alleghaniensis* and *Rhododendron* spp. One of the collections (GB 906) was fruiting on a reforested surface mine under *Picea abies* and young *Betula alleghaniensis*. Fruiting from late July to late August.

Material examined: FRANCE: Oise: Forêt de Compiègne, R. L. Shaffer 4624 (MICH). WEST GERMANY: Kniebis, R. L. Shaffer 7073 (MICH). GREAT BRITAIN: New Castle, Gosworth Park, R. L. Shaffer 6849 (MICH). U.S.A.: Virginia: Grayson Co., Headwaters of Big Wilson Creek, GB 880 (VPI). West Virginia: Pocahontas Co., Cranberry Glades, GB 447, Briery Knob, GB 906; Randolph Co., Headwaters of Otter Creek, GB 826; Tucker Co., Fisher Spring Run, Dolly Sods Wilderness Area, (all VPI).

Observations. This description is based on collections from eastern West Virginia and southwestern Virginia. The characters of these fungi did not agree with any of the species of the subsection *Emeticinae* described by Shaffer (1975). However, they were readily determined using the keys of Romagnesi (1967). The collections agreed well with the descriptions of Hora (1960) and Romagnesi. They were compared to European specimens of *R. betularum* and were microscopically identical to ones from Great Britain and Germany but had longer hymenial cystidia than another specimen from France.


20 µm
10 µm

Russula betularum is distinguished from *R. fragilis* (Pers.:Fr.) Fr. by its much paler pileus colors, absence of violet colors, larger spore size and broader, more clavate dermatocystidia. It differs from *R. silvicola* Shaffer by its paler pileus colors, smaller, more frail stature, more fragile, water-soaked trama and more clavate, more septate dermatocystidia.

RUSSULA PECKII Singer, *Mycologia* 35: 147. 1943. FIG. 2

This species is widespread in the northeastern United States and southeastern Canada. It reaches its most southern distribution in the red spruce-Fraser fir and red spruce-northern hardwood forests of the Southern Appalachian Mountains. *Russula peckii* has been collected in the higher elevations of the GSMNP near the southern limits of the red spruce-Fraser fir forests (Hesler, 1945, in part, as *R. purpurina* Quel. & Schulz.; Shaffer, 1970). The specimen described by Hesler (1945, L. R. Hesler 16313, TENN) from "frondose woods, foot of Mt. LeConte" was not *R. peckii* but rather a reddish specimen of *R. mariae* Peck. In addition to the herbarium material cited below, I have seen fresh material from the red spruce-Fraser fir zone of Roan Mt., North Carolina-Tennessee. I agree with Singer's observations (1943) that it is constantly associated with conifers, specifically *Abies* and *Picea*.

Shaffer (1970) provided a detailed description of this species. As he pointed out, this fungus can be easily recognized by the dry, velvety, dark red to pink pileus, crenulate lamellar edges, long, clavate, red to pink, white-based stipe, mild taste and strong red reaction of the incrusted cuticular hyphae with SV. However, Singer (1957) briefly redescribed *R. perplexa* Burlingham and indicated that it may be confused with *R. peckii*. A photograph is provided to illustrate the characteristic shape and stature of *R. peckii*.

Material examined: CANADA: Quebec: near Quebec City, S. Miller 621 (VPI). U.S.A.: New York: Essex Co., Huntingdon Forest, R. Singer 6-17 Sept 1941 (FH). Tennessee: Sevier Co.; Grassy Patch, GSMNP, A. H. Smith 10880 (FH), Indian Gap, L. R. Hesler 12189, Clingman's Dome, L. R. Hesler 15670 and 1 additional specimen, (all TENN). Vermont: Windham Co., Newfane, G. S. Burlingham 488-1912 (NY). Virginia: Grayson Co., Mt. Rogers, GB 885; Highland Co., Locust Springs, GB 513, (both VPI). West Virginia: Tucker Co., Headwaters of Otter Creek, GB 828; Webster Co., Tea Creek, GB 818, (both VPI).

FIGS. 25-29. *R. betularum* (GB 447). 25. Hyphal ends from pileus cuticle. 26. Caulocystidia. 27. Basidiospores. 28. Dermatocystidia. 29. Hymenial cystidia.

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MYCOTAXON

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REVUE DES LIVRES

par

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LA CHASSE ET LA CUEILLETTE AUJOURD'HUI. RECHERCHES ANTHROPOLOGIQUES, by C. BROMBERGE, G.LECUD & al. Numéro 87-88 of ETUDES RURALES de l'Ecole des Hautes Etudes en Sciences Sociales, Paris, 421 p., 16 x 24 cm., paperback, 1982. C.I.D., 131 Boulevard Saint Michel, 75005 Paris.

It is not usual to review anthropological studies in Mycotaxon, a journal devoted to fungi. This publication takes a backwards look, not at collected fungi, but at men collecting fungi and other natural goods. Collecting, gathering, hunting are considered at the same as a kind of human activities on which modern societies do not live anymore but still practice with meaning, as game, sport, pastime or relaxation.

The 27 ethnologists and sociologists contributing to that publication make an attempt to express the very nature of those activities, which is triple: utilitarian, cognitive and (or) symbolical. The multiple aspects (historical, economical, political, administrative, ecological, social and cultural) of hunting and collecting are considered as far as they have a significance in the relationship between men and the natural environment and between men themselves.

The chapters analyse thus those aspects through a few typical examples of hunting animals and collecting wild fruits. Very little is said about the collecting of mushrooms, but the book provides a mode of thinking about the way of life of the mushroom collectors (truffles, boletes f.i.) and their mutual relationship. Indeed, more specific studies are desirable in that respect.

Furthermore some of those non-violent activities, as collecting mushrooms or fungi in general, may be of mere cognitive nature and in that respect might need further development. Collecting fungi, or anything else, with the purposes of develop personal knowledge and of sharing the same with others on the field and later, is not considered. No doubt that such an activity is of anthropological significance.

PILZMIKROSKOPIE, PRÄPARATION UND UNTERSUCHUNG VON PILZEN, by Bruno ERB et Walter MATHEIS, in KOSMOS HANDBUCH für die praktische naturwissenschaftiche Arbeit, 166 p., 168 fig. including 135 colored photographs, 16 x 24 cm., hardcover, 1983. Franckh'sche Verlagshandlung W. Keller & Co, Stuttgart, Germany. Price:

Many mushrooms can be identified according to their characters of size, form, colour, odour or taste. The small species, however, as well as many large ones, require the use of the microscope.

This book is devoted to the field mycologist whishing to use the microscope and to the microscopist wanting to explore the fungus hidden world. It shows them both the pathway and the goal. It is alltogether a technical approach and a beautiful atlas of the fungal microcosme. The know-how of preparing slides, staining and measuring fungal constituents is acurately displayed. The results are orderly, visualized in the main chapter on the fungal anatomy, by numerous macro- and microphotographs, most in colours, with explanations given in legends, texts and tables. the illustration which covers the half of the 115 pages of that chapter is of high quality and shows all sorts of spores, spore markings, septation and appendages, basidia and cystidia, asci and paraphysae, hyphal tissues, hyphal clamps, setae, in natural or stain colours. The final chapter provides guidelines in eight practical examples, using the existing keys and analysing the microscopic characters. That book should receive a large diffusion, outside German speaking countries, for the amateur's training and for education.

FUNGI, FOLKLORE, FICTION & FACT, par W.P.K. FINDLAY, 112 p., 13 fig., 15 x 22 cm., broché, 1982. The Richmond Publishing Co. Ltd. Orchard Road, Richmond, Surrey TW9 4PD, U.K. Price: £ 4.95.

Les champignons, qu'on les craigne ou les admire, ont été, depuis longtemps, considérés comme mystérieux. Cependant, la connaissance de leurs propriétés et de leurs usages, pour le bien et le mal, remonte aux plus lointaines traditions. Ce livre de Findlay nous retrace quelques aspects de cette mycologie ancienne, qu'Aristote, Pline, Avicenne, Charles de l'Ecluse, Micheli, Linné et Persoons ont progressivement épurée et scientifiquement établie. L'empoisonnement prémédité de Claudius par Agrippine et Locuste au moyen de jus d'*Amanita phalloides*, les rites printaniers de la campagne romaine en l'honneur du dieu Robigus, le maître de la rouille des blés (*Puccinia graminis*), l'usage médicinal à tort ou à raison par les herboristes du moyen âge, de champignons tels que *Fomes officinalis* ou *Phallus impudicus*, les maladies redoutées comme le "feu de la St Jean" ou "feu sacré" dû à l'ergot de seigle (*Clavices purpurea*), la "lèpre"des maisons causée par le *Serpula lacrymans*, les manifestations mystérieuses des "ronds de sorcières" (*Marasmius oreades*), des "balais de sorcières" (*Exsidia glandulosa*) et des "feux du diable" (*Armillariella mellea, Pleurotus olearius*) et les effets psychédéliques des champignons sacrés hallucinogènes du Mexique (*Psylocibe mexicana, Psylocibe zopotecorum*), du champignon de St Isidore (*Stropharia*) et de l'agaric tue-mouche (*Amanita muscaria*), tout nous est raconté par l'auteur sur la base de textes anciens. Mais aussi, il nous rappelle la culture sur bûches de la pholiate du peuplier (*Agrocybe cylindracea*) pratiquée par les Romains, et les assertions d'ailleurs vérifiées que les champignons, appelés par Cordier la "manne du pauvre", produisent leurs protéines en des temps tellement plus courts que ne le fait l'animal (A. Proost, 1884) et avec un rendement à l'hectare de 830 fois supérieur ! Ce livre est passionnant.

E.C. STAKMAN, STATESMAN OF SCIENCE, par C.M. CHRISTENSEN, 156 p., 27 fig., 15 x 23 cm., relié, 1984. The American Phytopathological Society, 3340 Pilot Knob Road, St Paul, Minnesota 55121, USA. Prix: US $ 18.

Dr. Elvin Charles Stakman (1885-1979) fut un scientifique brillant, un éducateur de talent et un homme passionné. Par ses nombreuses découvertes sur les maladies de plantes, et en particulier sur les rouilles et les charbons, consacrées par 307 publications, il est aujourd'hui considéré comme un des créateurs de la phytopathologie moderne, démontrant l'efficacité des moyens de lutte adéquatement appropriés à l'épidémiologie de la maladie.

Stakman fut aussi un éducateur de grande envergure. Dès la fin de ses études, il fit réalité de ses idées d'avant-garde dans l'école secondaire qu'il avait été, à 23 ans, amené à diriger et ce fut le succès. Il entra à l'Université de Minnesota, à St Paul, en 1909, comme chargé de cours en phytopathologie et en botanique et dès 1913 y devint Professeur responsable de la recherche. Il collabora ensuite beaucoup avec les Stations de recherches du Departement de l'Agriculture des Etats Unis, ainsi qu'aux Programmes Agricoles de la Fondation Rockfeller au Mexique et en Amérique Latine.

Cette biographie est un hommage de son disciple et successeur et, par lui, de tous ses anciens élèves. Elle est d'autant plus vivante qu'elle reprend de larges extraits d'écrits et de récits de Stakman reçus ou enregistrés par l'auteur. La richesse de vie de l'homme de science, d'action et de dévotion transparaît tant au long du récit qu'elle ne peut qu'enthousiasmer le lecteur.

COMPENDIUM OF STRAWBERRY DISEASES, par J.L. MAAS, A.P.S., The Disease Compendium Series n°11, 138 p., 156 fig., 148 phot. coul., in 4°, broché, 1984. The American Phytopathological Society, 3340 Pilot Knob Road, St Paul, Minnesota 55121, USA. Prix: US $ 12- (members), 15- (non members).

Ce compendium est le premier de cette série qui traite des maladies d'une plante fruitière, le fraisier. Dr. Maas, l'auteur responsable, regroupe ces maladies et y distingue 18 types de dégât, par insectes, acariens et mollusques, 2 maladies bactériennes, 8 maladies fongiques du feuillage, 33 maladies fongiques des fruits, 24 maladies fongiques des racines et du collet, 21 maladies à virus, 2 maladies par nématodes et 16 désordres physiques ou physiologiques de causes diverses. Il est bien vrai que le fraisier est une plante délicate. La présence de champignons mycorhizogènes est également signalée. La multiplication du fraisier par la culture pure des tissus est aussi illustrée, ainsi que la détection des virus et mycoplasmes par la greffe foliaire. La documentation en couleurs (21 pages) est particulièrement choisie et intéressante. L'illustration photographique blanc-noir est aussi bonne. Les dessins descriptifs des champignons et des cycles épidémiologiques, réalisés par Marie Finney, souvent inspirés d'autres sources, sont malheureusement schématiques et imprécis. Une inversion de deux d'entre eux est mentionnée dans l'erratum. Ce fascicule du Compendium est une très bonne et parlante synthèse des multiples maladies des fraisiers. Il sera d'une grande utilité aux phytopathologues et aux fraisiéristes.

FLORE ILLUSTREE DES CHAMPIGNONS D'AFRIQUE CENTRALE. 10. GYRODONTACEAE P.P. (BOLETINEAE), by P. HEINEMANN, J. RAMMELOO, p. 178-193, 22 fig., pl. 22-24 (coloured), 25 (black-white), 31,5 x 24 cm, in map., oct. 1983. Jardin Botanique National de Belgique, Domaine de Bouchout, B-1860 Meise, Belgium. Price: 550 FB.

This fascicle is the tenth of the FLORE ILLUSTREE DES CHAMPIGNONS D'AFRIQUE CENTRALE, a continuation of the FLORE ICONOGRAPHIQUE DES CHAMPIGNONS DU CONGO (18 volumes, 1935-1972, 5.500 FB). Like the latter, the FLORE ILLUSTREE DES CHAMPIGNONS D'AFRIQUE CENTRALE (1972-) mostly deals with higher Basidiomycetes at the exception of fascicles 8-9 on the Trichiales (Myxomycetes).

The fascicle 10 is the second part of the study of the *Gyrodontaceae* started with fascicle 7.

The authors of the fascicle 10 redescribe 6 species of *Gyrodon*, 1 species of *Pseudogyrodon*, 5 species and varieties of *Gyroporus*, 9 species and varieties of *Rubinoboletus* and 1 species of *Setogyroporus*. A general key to the subfamilies, genera and species of the *Gyrodontaceae* is given. The macro and microscopic descriptions and the critical comments on the collections of each species are illustrated by colour photographs and waterpaintings of the specimens. The quality printinf is excellent.

MORE BIRD'S NEST FUNGI (NIDULARIACEAE). A SUPPLEMENT TO "THE BIRD'S NEST FUNGI" (1975), by Harold J. BRODIE, LEJEUNIA, n.s. 112, 70 p., 10 fig., 16 x 22 cm., 1984. Editions de Lejeunia, Département de Botanique, Sart-Tilman, B-4000 Liège, Belgique. Prix: 260FB (in Europe) or 300FB (abroad).

After the publication of Dr. Brodie's wonderful book THE BIRD'S NEST FUNGI in 1975, fourty-eight more papers have been contributing to the knowledge of these attractive fungi.

As far as morphology is concerned, SEM observations of the structure of the fruit bodies, especially of the funicle of the peridioles, have confirmed the observations made under the light microscope. The spores prove to be smooth. The funicles are composed of different kinds of extensible hyphae. In four species of *Nidula*, antler-hyphae covering the peridioles are shown to play a role of wettability in the dissemination of the fungus by rain drops and are also of taxonomic value.

Brodie's culture medium reveals to be stimulating the fruiting of several species. The cultures of the nidulariaceae have helped the demonstration of their efficient biodegradation of lignocellulose into simple carbohydrates. They also permitted the discovery of as many as fifty new chemical substances, as terpenoids with antimicrobial activity.

Taxonomic developments mainly consist in the recent description of five taxa by Brodie and Sharma, *Cyathus crispus*, *Cyathus ellipsoideus*, *Cyathus griseocarpus*, *Cyathus olla f. lanatus*, *Cyathus pedicellatus*, and the reappraisal of two Lloyd's species, *Cyathus triplex* and *Cyathus canna*.

At the end, the author tells us with humor very true experiences of collecting bird's nest fungi in the *Nidulariana 9-12* as he did in his book. Anyone who got Brodie's book must have this necessary updating.

FUNGORUM RARIORUM ICONES COLORATAE, PARS XIII, BOLETES II, by Aurel DERMEK, 15 p., 8 fig., 8 col. pl. (pl.97-104), 17 x 24 cm, paperback, 1984. J. Cramer, A.R. Gantner Verlag, Fl-9490 Vaduz, Lichtenstein. Price: DM 30.- (subscription) or 35.-

Eight rare species of boletes from Tchchoslovakia are beautifully illustrated by the author's waterpaintings:

Buchwaldoboletus lignicola, Xerocomus moravicus, Boletus betulicolus, Boletus edulis var. *arenarius, Boletus pachypus, Boletus lupinus, Boletus erythropus* var. *rubropileus* and *Leccinum atrostipitatum.* This fascicle XIII is, like the previous one, of very good printing quality.

SOUTH INDIA AGARICALES, a preliminary study on some dark spored species, by K. NATARAJAN and N. RAMAN, Bibliotheca Mycologica, n° 89, 203 p., 26 fig., 15 x 23 cm, hardcover, 1983. J. Cramer, A.R. Gantner Verlag, FL-949 Vaduz, Lichtenstein. Price DM 80.-/100.-.

A survey of the literature on the agaric flora of India revealed only 610 recorded species of Agarics belonging to 90 genera and demonstrated the need for intensive collecting and studies. After having published several papers on white spored agaricales from South India, the authors report here their discoveries of 82 more species and 4 varieties of Agaricales belonging to 22 black spored genera from South India. They represent the families *Coprinaceae, Bolbitiaceae, Strophariaceae, Cortinariaceae* and *Crepidotaceae*. Fourteen of those species are described as new ones. The line drawings illustrate the carpophore, basidia spores, cystidia and velar elements for each of the species. The authors have added a list of the previous species recorded from South India.

THE GENUS COLLYBIA (AGARICALES) in the north-eastern United States and adjacent Canada, by Roy E. HALLING, Mycologia Memoir n°8 of The New York Botanical Garden and The Mycological Society of America, 148 p., 119 fig. (incl. 22 b-w. phot.), hardcover, 1983. J. Cramer, Springaeckern 2, D-3300 Brauwchxeig, Germany.

Collybia (Fr.) Staude, a genus quite uneasy to delimit from *Marasmius, Flammullina, Tricholoma, Clitocybe* and others, has been reappraised in the last twenty years, laying the emphasis on the microscopic characters. The author distinguishes two subgenera, *Rhodocollybia* and *Collybia* on combined spore deposit colour and reactivity to melzer's reagent and cotton blue. Sections in the subgenus *Collybia* are characterized by their type of hyphal arrangement in the pileus surface, radial or interwoven. Furthermore the substrate is quite restricted to particular species and is of taxonomic value. The only one *Collybia butyracea* is mycorrhizal.

Three new species are described, *Collybia egregia, Collybia dysodes* and *Collybia subtergina*. Three new combinations and one new name are proposed.Thirty-two species are recognized and 84 excluded or doubtful. In the descriptions of the species, we will notice the author's care to detail the cortical hyphal layers of the pileus observed from radial, tangential and paradermal thin sections of the mid-region. Line drawings show anatomical characters, spores, cystidia. Photographs represent the carpophores in a fresh state.

AD POLYPORACEAS I, AMAURODERMA AND GANODERMA, by E.J.H. CORNER, Beihefte zur Nova Hedwigia 75, 182 p., 31 fig., 17 x 25 cm, hardcover, 1983. J. Cramer, A.R. Gantner Verlag, FL-9490 Vaduz, Lichtenstein.

Dr. Corner gives us his thoughtful deliberations (in Part 1) and much original taxonomic material (in Part 2) for a hitherto not established generic and family classification of the *Ganodermataceae*. Five genera have been distinguished within the family, *Ganoderma* and *Amauroderma* by Patouillard, *Humphreya, Haddowia* and *Megaderma* by Steyaert. The author analyses each supposedly diagnostic character carefully and demonstrates at one hand the synonymy of *Megaderma* and *Amauroderma* and at the other hand the overlapping of the three remaining genera. Indeed the so called "anomalous" species in each of those genera simply show features that should justify their place in two or the three genera. If the author uses the generic names as they are, it is for temporary convenience, but he would reconsider them at the subgeneric level.

The family concept is also questionned. Its relationship with *Polyporus* at one side and *Fomitopsis* at the other side needs clarification. Both spores and hyphal systems exhibit more variety than has been assumed. The hyphal systems vary from the trimitic system with skeleto-binding hyphae to the dimitic one with unbranched skeletal hyphae. The spores vary from colourless to coloured, from umbonate and multitunicate to subglobose and unitunicate.

In the second part, the author describes fruit bodies, in the fresh state, of some 44 tropical species (16 neotropical and 28 Asian and Australasian, many collected in Malaisia). Names are not or only tentatively applied to some collections needing further studies. However 19 new species and varieties are proposed.

The book is intended to be a first contribution to the Polypores. The author emphasizes the need of a study of the tropical polypores and in the fresh state to help filling up the holes and resolving the uncertainties of the present classification.

THE GENUS PSILOCYBE, a systematic Revision of the known Species, including the History, Distribution and Chemistry of the hallucinogenic Species, by Gaston GUZMAN, Beihefte zur Nova Hedwidgia 74, 440 p., 781 fig. in text and in 40 pl., 59 fig. col. , 17x25 cm, hardcover, 1983. J. Cramer, A.R. Gantner Verlag, Fl-9490, Lictenstein. Price DM 160.- (subscr.) or 200.-.

The Mexican Hallucinogenic fungi have been brought to the attention of mycologists for more than 40 years. No monograph of the genus *Psilocybe* has been made however. Kühner and Romagnesi's book (1953) recognizes 13 species, Singer's *Agaricales in modern Taxonomy* (1975) 48 out of many more. Guzman has considered 467 specific names and recognizes 144 good species, of which 52 have been or are described by him as new. 90 names are placed in synonymy, 119 are of doubtful status and 114 are excluded. The descriptions of the 144 species are based on the type material and on many dried or fresh collections from Mexico and other parts of the world, gathered over almost 30 years.

The monograph follows the standard pattern of taxonomic treatments of Agaricales. A first part deals with taxonomic characters, ecology and distribution. A second part reviews the discovery, the use, the distribution of the hallucinogenic fungi in the world and of the hallucinogenic *Psilocybe* species and their active hallucinogenic substances.

The taxonomic part confirms the position of the genus and justifies its subdivision into 18 sections, of which 14 are created by the author to accommodate the 144 species. The sections are based on 12 distinct characters: the colour of the cystidia, the presence of an annulus, the spore shape and length and the distribution are the most important. Each description is followed by the list of the specimens and illustrated by line-drawings of carpophores, cystidia and spores. All doubtful species are carefully documented. An abundant photographic illustration helps visualizing the natural habit of the fungi.

This monograph is a world monograph and will be useful to many.

A MONOGRAPH OF THE LICHEN FAMILY MEGALOSPRACEAE, by H.J.M. SPIMAN, Bibliotheca Lichenologica 18, 242 p., 24 phot. pl., 15x23 cm, hardcover, 1983. J. Cramer, A.R. Gantner Verlag, FL-9490 Vaduz, Lichtenstein.

This world revision of the *Megalosporaceae* (*Lecanorales,* lichenized Ascomycetes) is based on a reevaluation of the morphology (using SEM microscopy), anatomy (using freezing microtome sections) and chemistry (by thin layer chromatography) of the thalli ad apothecia and on an emphasis of the apothecial ontogeny. 1200 herbarium specimens and many fresh collections from Central and Southern American, Australia and New Zealand have been studied. Two new genera, *Austroblastenia* and *Megaloblastenia,* with two species each, are added to the world spread genus *Megalospora,* which, after emendation, includes 29 species and subspecies, including the type species of *Bombyliospora.* 11 species and 3 subspecies are new.

The genera are delimited on their spore structure. The species are mainly based on the epithecium pigmentation and granulation (SEM), spore structure and size, hymenium size and thallus chemistry. Each taxon description is completed by the reference of the type, a map of distribution nd taxonomic comments. The species are not illustrated by line drawings, but many of them documented by black and white photographs.

The main feature of this monograph is the author's care in discussing the generic delimitation and the family taxonomic position through a detailed study of the taxonomic characters, and in reconstructing a possible evolutionnary history of the family through a full study of the ecology and the geographical distribution of the collected species. Basing on a cladistic analysis, the family ancestor is shown to possibly have had bicellular spores with thick septa. The evolution is supposed to have taken place on Gondwana-land from which the species migrated into tropical regions and southern hemisphere.

THE BITUNICATE ASCOMYCETES AND THEIR ANAMORPHS, by A. SIVANESAN, 701 p., 376 fig. in text, 15x23 cm, hardcover, 1984. J. Cramer, A.R. Gantner Verlag, FL-9490 Vaduz, Lichtenstein. Price DM 160/200.

The book is a compilation of the present knowledge of correlations of anamorphs and teleomorphs in the Loculoascomycetes, brought into integrated descriptions and illustrations. The Loculoascomycete species without anamorph and those with anamorphs but not supported by available material or sufficient documentation have been omitted.

The classification follows that one proposed by Eriksson in *Opera Botanica* 60, 1981, based on 7 orders and 38 families. 20 of those families are considered here for their anamorphic connections. Keys to the families and genera and to the species with anamorphs in each genus are given. Each taxon is provided with their teleomorphic and anamorphic names, synonymy, original references and eventually a reference to the paper establishing the connection. The descriptions are reduced to the essential features. There is no information on type material, even when illustrated. About 375 but not all species are illustrated by line drawings of their teleomorph and anamorphs. A cross index of the connected morph generic names achieves the work.

The author intended his book as a guide. I will surely be guiding the identification, the keys using both sexual and asexual morphology. It will be also a reference in establishing new connections between teleomorphs and anamorphs. As a guide, it does not provide all useful datas on the included species, nor repeat useful bibliographic references available in other general works.

THE ASCOMYCETE GENUS EUPENICILLIUM AND RELATED PENICILLIUM ANAMORPHS, by Amelia G. STOLK and Robert A. SAMSON, Studies in Mycology 23, 149 p., 72 fig., paperback, 1983. Centraalbureau voor Schimmelcultures, Baarn, Nederland. Price Hfl 45.-.

While Pitt (1980) disposed into 8 series the 37 species recognized by him in *Eupenicillium*, the authors propose a rearrangement of 33 species only (including 3 species newly assigned to the genus) into four sections: *Eupenicillium, Lapidosa, Pinetorum* and *Javanica*. The sections are primarly based on the anamorphs. The species are diagnosed by their morphological characters only, i.e. the structure of the ascogenous hyphae, the development and grouping of the asci, the ornementation of ascospores, the shape of phialides and conidia. Each species is illustrated by line drawings of the type and several other strains and by SEM photographs of ascopores.

The authors noticed a large variation as well in the ascospore size as in the anamorphic pattern and cultural appearance, leading to a broader species concept and the synonymy of many *Penicillium* species. A synoptic key of all the taxa shall help to their identification.

Ramírez (1982) did not include the genus *Eupenicillium* in his *Manual and Atlas of the Penicillia* intendedly. This monographs thus completes adequately the Ramirez's book.

A REVISION OF THE GENUS SPOROTRICHUM, by J.A. STALPERS, Studies in Mycology 24, 105 p., 15 fig., paperback, 1983. Centraalbureau voor Schimmelcultures, Baarn, Nederland. Price Hfl 25.-.

The genus *Sporotrichum* Link (1809), in agreement with its type species, is now restricted to anamorphs of lignicolous basidiomycetes with stalked broadly attached terminal blastoconidia born to racenosely branched conidiophores. It includes three species only, *S. aurantiacum, S. pruinosum* and *S. versisporum*. Their teleomorphs belong to *Pycnoporellus, Phanerochaete* and *Laetiporus* repectively.

Over 175 years, the genus has been extended as much as to include 319 taxa with 339 epithets. All the epithets have been checked. Most are anamorphs of ascomycetes. Many are redisposed in *Sporothrix* (pathogenic) and *Geomyces*. Twelve new combinations are made in *Arthrographis, Basipetospora, Geniculosporium, Piloderma, Pycnoporellus, Rhizopus, Disporotrichum, Talaromyces, Tomentella* and *Ugola*.

THE FUNGAL COMMUNITY, ITS ORGANIZATION AND ROLE IN THE ECOSYSTEM,
by Donald T. WICKLOW and George C. CARROL ed., Mycology Series 2
(P.A. LEMKE ed., Auburn University, USA), xviii + 855 p., ill.,
4° (19x26 cm), hardcover, 1981. Marcel Dekker Inc., 270 Madison
Ave, New York, NY 10016 USA, and Basel, Switzerland. Price SFR 280.

"The aim if this book is nothing less than evangelical" said Dr. Swift in the foreword; that means that "from this book mycologists can learn to interpret their data, ecologists to substantiate their theory."

The fungi are important actors if this world, one knows it. That is surely justification enough for looking at their ecology. The book is divided in 8 parts, leading, like in classical ecology textbook, from fundamental principles to their applications.

The first part examines the contribution of fungal ecology in developing ecological theory, through the identification of concepts for the study of fungal populations and through the correct sampling of the population as an adequate representation of the fungal dynamics. The coprophilous fungal community is given as an example. The niche concept is considered in part 2. According Hutchinson, it is made of a fundamental aspect, the expression of the genome, and of a realized aspect, a response to the presence of competitors. The niche is the result of physiological and biochemical adaptations of the organisms. So it is shown in the case of lichens in severe environments, of zoosporic fungi in stagnant waters, of cactophilic yeasts on necrotic cacti.

Part 3 is important as it deals with quantitative description and evaluation of the fungal communities, as a mean for their characterization, comparison and understanding of their internal and evolutive dynamics.It mainly concerns the soil mycoflora and its approach.

The internal organization of the fungal community is depending on the biotic interactions among individual species (Part 4). Mutualism, mycoparasitism, competition, antagonism regulate the community, also the interference of protozoan and arthropods predators cannot be ignored. Part 5 studies the processes of the fungal community evolution in time (mycoflora succession), in regards to the colonization and degradation of the substate and in response to changes in the ecosystem by maturation or disturbance.

Part 6 and 7 deal with the role of the fungi in the ecosystem and the evaluation of fungal biomass production and turnover rates. Quantitative and accurate measuring methods of fungal production and activities are usualy laborious. However methods have been successfully applied in evaluating the decomposition rate in leaf litter, the production of basidiomycete fruitbodies, the fungal biomass in soil, the enzymatic turnover of organic matter, the uptake of nitrogen and phosphorous by mycorrhizal fungi.

At the end, part 8 proposes the aquatic hyphomycete community as an exemplary ecosystem for the applied study of the multiple aspects of fungal ecology. Indeed much has been done in that field but much remains to do in quantitative ecology. The same can be asserted for so many other natural or disturbed ecosystems.

The book is a milestone. It is a stimulating reading. It must enhance a very progress in conceptual, methodological and comprehensive fungal ecology. It is a need.

*THE FILAMENTOUS FUNGI. VOL. IV. FUNGAL TECHNOLOGY,*by Jŏhn E. SMITH, David R. BERRY and Bjorn KRISTIANSEN, 401 p., ill., 16x24 cm, hardcover, 1983. Edward Arnold Publ., 41 Bedford Square, London WC1 B3DQ, UK. Pric £ 32.50.

This book examines the technological aspects of the use of filamentous fungi in bioindustries. It is complementary to the first volume of the series, *Industrial mycology*, an account on the past and current industrial use of the fungi.

The large-scale industrial cultivation of filamentous fungi in liquid or solid state requires refined equipments and precise technological, chemical and biological control technics.

Four chapters deal with the fundamentals of the liquid cultivation of mycelia: fluid rheology, fermenter design and functions, mass transfer across gaz-liquid-solid interphases, heat transfer, instrumentation for measurement of parameters, data record, storage and analysis, mecanisms of control, computed monitoring systems and industrial scale-up in aerobic fermentation.

Chapters 5 and 7 detail principles and applications of solid and semi-dolid state fermentation, where the solid substrate water content does not exceed its water retention capacity. The mass transfer of nutrients and metabolites between solid particles and inside the particles is considered in various cases. Ensiling, composting, oriental food production such as koji, tempeh, miso, sake, soy sauce, tapeketan, cheese fermentation, biomass, fungal protein or mushroom production, enzyme and other productions from straw are extensively explained.

Another chapter reports on the increasing development of the immobilized cell technics and film reactor systems for filamentous fungi in view of production of highly valuable fungal metabolites. Also the use of mycelial pellets for specific fermentations is mentioned.

The optimization and the reduction of cost in production are the next steps. The authors explain in chapter 8 how high yields and low cost are assured by controling the inoculum, the nutrients and the culture kinetics and parameters in an antibiotic production plant.

The recovery of the metabolites is the final step and involves processes such as filtration, mycelium drying, grinding and milling, extraction and purification of the final product. Two special chapters deals with the degradation and the conversion of raw lignocelluloses, celluloses and hemicelluloses in simple sugars like pentoses and the production of ethanol by using fungal enzymatic activities.

Safety for man are also considered in the production of insect pathogenic spore masses, as well as in the control of mycotoxins in fermented foods.

In prospect of future progress in fungal bioproductions, the fungal genetics shows similar developments as bacterial genetics. Mutagenesis, breeding, protoplast fusion and gene manipulation are already classical or new ways of progress.

To the mycologist looking around his own special field, to the biochemist, to the industrial microbiologist, to the biotechnologist and food technologist, this book will bring a broader scope on the potentialities of fungi in service to man. For its easy reading, it is also recommended in general microbiology education.

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NOTICE

SOME MINOR EDITORIAL CHANGES

Beginning with manuscripts submitted for volume 22, we will be able to provide **only** offprints of articles, **not** reprints. Offprints will be shipped within a few days of publication, but will not bear the exact date of publication, which of course can be added by authors on receipt of the offprints, should they so desire. It will be possible to order offprints with or without covers.

At the close of the press run we plan to return to the submitting author (1) the original manuscript together with any figures, (2) the negatives from which the photo-offset plates for publication were made, and (3) typed cover copy bearing notation of the exact date of publication, suitable for use in making covers (or self-covers) of any reprints. All these will be sent whether or not offprints were ordered. Ordinary surface mail will be used unless authors wish to pay for insured or registered mail costs to guard against loss in the post, or wish to assume costs of airmail return. It will thus be possible for authors to have their local printer prepare reprints from the negatives, should they so desire. We remind authors that our halftones use 150-line screens, and that if their article includes halftones, they should be certain their reprint printer is capable of handling such material. We can provide the name of the printer in Ithaca, New York, where reprints were formerly printed, but arrangements and costs of reprints will be a matter for the authors and the printer to determine.

Authors should be aware that costs of halftones have increased greatly. We still allow one halftone free per ten pages of total manuscript. The current cost of excess halftones is $15 each, which will be charged to the authors. They should consider grouping halftones when the subject matter allows, since two small halftones cost twice as much as one, full-page halftone.

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